# YCHOLOGY

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PSYCHOLOGY

# PSYCHOLOGY

BY

BURTIS BURR BREESE

PROFESSOR OF PSYCHOLOGY IN THE UNIVERSITY OF CINCINNATI

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# PREFACE

The present text aims to give a comprehensive view of the facts, principles, and theories of human psychology. Accordingly, the student will find that it represents the various points of view of modern psychology—the analytic and the descriptive, the structural and the functional, the genetic and the physiological. At the same time the empirical results of experimental psychology are used as far as possible. Thus at the beginning the student is given a broader foundation for the understanding of mental life than could be given by a more limited point of view.

From the very outset an attempt has been made to differentiate the metaphysical and the empirical tendencies in psychology. It is important that the student should know when he is indulging in naïve metaphysical speculation, and when he is dealing with the results of scientific observation or the theories based upon such observation.

While I am in sympathy with the present attempt now being made in some quarters to emphasize the objective and quantitative aspects of consciousness, nevertheless I confess the belief that the qualitative aspect is still worthy of psychological consideration, and that, in order to get at this qualitative aspect. the method of introspection is still a valid method of psychological procedure.

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B. B. B.

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## CHAPTER I

### INTRODUCTORY

Psychology is that study whose task it is to point out and organize the observable facts of conscious life, and to formulate the theories, or hypotheses, necessary to explain these facts. In this study it is important that the student should distinguish clearly between fact and hypothesis—between what is obtained through scientific observation and what is logically constructed through speculation. Psychology was in its earliest stages a branch of philosophy, and was more inclined to speculate about the nature of consciousness than to observe and systematize the facts connected with it. This is illustrated in the attempts to explain consciousness in terms of the soul, a metaphysical being beyond actual observation. Modern psychology concerns itself more with the facts and less with the ultimate nature of consciousness.

If we consider all the facts which come from actual observation we may put them into three groups:

1. Facts about matter.
2. Facts about life.
3. Facts about consciousness.

The first group forms the subject-matter of the material sciences; the second group forms the subject-matter of the biological sciences; and the third group forms the subject-matter of psychology.

**Divisions of Psychology.**—There are a number of special forms of psychology determined by the fields of mental life from which the psychologist draws his material, and by the methods and points of view he employs in his study. With respect to the fields of consciousness we have:

1. Adult human psychology.
2. Child psychology.
3. Social psychology.
4. Abnormal psychology.
5. Animal psychology.

With respect to methods and special points of view we have:

1. Descriptive psychology.
2. Experimental psychology.
3. Genetic psychology.
4. Functional psychology.
5. Physiological psychology.
6. Psychophysics.
7. Comparative psychology.

*Adult Human Psychology* considers the consciousness found in the adult human being. It points out the common qualities, processes, and modes of activity found in human beings generally. Since individuals differ from each other in mental characteristics, a study of these differences is also important. This study has been termed individual psychology.

*Child Psychology* deals with the conscious states of the child. It takes account of the stages of mental development through which the child passes. Since the genesis of consciousness is important here, child psychology is a part of genetic psychology; and since a large part of the child's life is spent in school under a formal educational system, child psychology and genetic psychology often take the form of educational psychology.

*Social Psychology* has to do with conscious experiences which are made possible by the presence of an individual mind in a group of other minds. Such experiences are due to what has been termed social consciousness. Out of it spring language, laws and customs, myths and religion—all of which are dependent upon the existence of a community of individuals. The use of the terms "social consciousness" and "collective mind" must not be understood to indicate the assumption of the existence of another kind of consciousness other than that found in individuals. These terms refer only to the conscious states in individuals which are due to a community of minds. Communities of people have the same language, customs and fashions, religion and mythology. The conscious experiences back of these institutions we assume to be the same in all individuals. Since much of our mental life is social, social psychology overlaps normal adult psychology and draws its material from it. A subdivision of social psychology, variously named as *race psychology*, *ethnic psychology*, or *folk psychology*, is interested in the mental characteristics of different races or peoples. It may include the comparison of the mental traits found in different peoples. We may compare the Japanese, on the one hand, with the Russians on the other; or the primitive races, like the American Indians or Malays, with the more civilized races. A still further subdivision might take up the study of classes, professions, and occupations.

*Abnormal Psychology* deals with abnormal mental states, such as hypnotism, double or multiple personality, fixed ideas, hysterias, mania, melancholia, dementia, paranoia, idiocy. Here also should be included the study of deficient and exceptional minds—the weak-minded and the genius. The criminal mind belongs in this list, because most criminals are abnormal.

*Animal Psychology* takes as its subject-matter the mental states of animals. The absence of language in animals limits the possibilities of studying the consciousness which we know exists there. Man can describe his experience in language, but animals cannot. However, the behavior of the animal is a clew to the kinds of consciousness it has. We may therefore study its behavior and so, indirectly, its consciousness. Since we may proceed from the lowest animal forms to the highest, animal psychology may be genetic in its point of view.

*Descriptive Psychology* is really a method of studying consciousness. It analyzes, describes, and classifies conscious experiences.

*Experimental Psychology* is laboratory psychology. Laboratory methods and physical apparatus are used as means of controlling and studying mental states. Of course, the psychologist cannot measure or weigh the conscious states of his subjects. He cannot even observe them directly. He may, however, measure the time during which a conscious state exists. He may measure or weigh the physical stimuli and correlate the results with the intensities of the conscious experiences. He may also note the physiological changes which take place in the body while the conscious states are going on. For all this he uses instruments of precision, but nowhere in his laboratory has he an instrument that will measure a mental state itself. A large part of this study depends upon the introspective report given by the subject.

*Genetic Psychology* considers the successive stages of mental growth and the evolution in the individual and in the race. We may use a pair of terms that are common to biology and psychology to designate the two lines of development —*phylogenesis*, or racial development, and *ontogenesis*, or individual development. These terms really refer to the growth and development of organisms as a whole—both mind and body. Mental development in phylogenesis includes all the stages of conscious life which appear in the evolution of animal forms from the lowest to the highest. These stages of development may be considered either as a series now existing, or as a series constituting the successive stages of evolution from the earliest time to the present. Mental development in ontogenesis includes the stages of development which take place in an individual from birth to death. The biologist finds a relation between ontogenesis and phylogenesis which he states as the principle of recapitulation. According to this principle, the individual in embryo passes through the same stages of development that the race has passed through. Thus, biological recapitulation suggests a problem for genetic psychology: Does the child in his mental development pass through the stages of mental development that the race has passed through?[1] The chief problem of genetic psychology, however, is that of making out the stages of mental development of the individual.

*Functional Psychology* looks upon consciousness as a process. Formerly the mind was supposed to possess the functions of knowing and willing. Later a third function, that of feeling, was added. Knowing, feeling, and willing are, from the point of view of functional psychology, the functions of the mind. A more recent functional point of view asserts the presence in the mind of a purposive factor which determines the direction and nature of conscious processes. While external conditions (stimuli) do this to a certain extent, it is claimed that these factors are not sufficient to explain conscious activity adequately. A conscious agency, therefore, is assumed to account for the character of our conscious states.

*Physiological Psychology* considers consciousness as either the direct outcome or the correlate of brain activity. Physiological psychology does not, however, necessarily commit itself to a materialistic philosophy. For consciousness may be non-material or spiritual in its nature and yet be dependent upon the brain for an opportunity to manifest itself. The brain may be only the medium or agent for consciousness and not its real cause. But whether its philosophy is materialistic or spiritual, it bases its particular point of view and its method upon the observable fact of correlations between consciousness and nervous processes in the brain. It accordingly takes the activity of the nervous tissue as its starting-point, acquaints itself with the facts of the anatomy, histology, and physiology of the nervous system, and at-

[1] For a discussion of this question the student is referred to "Mental Development in the Child and the Race," by James Mark Baldwin.

tempts to find out what happens in the brain when we are conscious, or, more exactly, to find out what the correlations are between the nervous activities on the one hand and mental states or activities on the other. It really combines a large part of neurology (that which has to do with the higher brain centres and their connections) with psychology proper. One of its important problems is the localization of brain centres for the different conscious processes. For example, it finds the centre for sight in the occipital lobes of the brain, the centre for hearing in the superior convolution of the temporal lobes, and so on. In the present state of knowledge of the physiology of the nervous tissue there is relatively little known concerning the nervous action in the brain. At the present time, then, physiological psychology can be little more than the statement of a series of neurological facts on the one hand, and of conscious facts on the other.

*Psychophysics* is the study of the relations which exist between consciousness and the world of physical objects which are capable of acting as sense-stimuli. It is a partnership between physics and psychology, and is included under experimental psychology as now carried on in the psychological laboratory.

*Comparative Psychology* has taken at least two directions. In some quarters it has been identical with animal psychology and has occupied itself with the comparison of the mental life found in the various types of animals. This might well include a comparison of the mental life of the animal forms with that of man, but this is a problem for the future. A wider significance has been given in other quarters to comparative psychology in that it is considered as a comparison of the normal human adult consciousness with that found in the child, in abnormal man, in social groups, and in animals respectively.

**The Procedure of Psychology.**—Although the array of psychologies seems rather long and perplexing, the matter becomes really very simple when we remember that they are all studies of consciousness, and that consciousness is found only in human beings and animals. Nearly all these forms of psychology are simply special methods, or points of view, used in the study of animal and human consciousness. A general psychology, such as we are entering upon, takes for its subject-matter the highest type of consciousness—that of the adult human being. But it may make use of any of the different special methods and points of view, or even of the subject-matter of the different psychologies, in so far as it is helpful in understanding the mental life of normal man.

The fundamental method of psychology is *observation:* first, the observation of the mental states and processes taking place in our own minds, and second, the observation of the behavior of others by means of which we may infer the presence and nature of their mental states. These two forms of observation are necessary in psychology. Without the first we could never have an intimate first-hand acquaintance with the facts of consciousness, and without the second we would know nothing of consciousness outside our own minds.

The first form of observation gives us direct knowledge of our own conscious life and has been termed—*introspection, i. e.*, looking within. Introspection is the observation of our own mental states. This self-observation does not, however, presuppose a new process or method of observation introduced by the psychologist. Introspection does not differ fundamentally from the observation employed in the other sciences. The difference lies only in the material upon which it works. Introspection in psychology is observation of mental facts, while observation in the other sciences is observation of material facts. Introspection has sometimes been taken to be an inner consciousness in distinction to an outer consciousness which knows the outer world of objects. But there is no valid ground for such a distinction. All consciousness, whether it be awareness of mental states or of material objects, is of the same character. The distinction of inner and outer has no meaning when applied to consciousness itself. The awareness of a material object is just as much inner consciousness as the awareness of a mental state. Both are contents of consciousness. The ability to introspect improves with training and practice. The novice in psychology is quite as helpless as the beginning student in biology when given his first high-power microscope. Expertness is needed no less for the accurate observation of mental states than for the accurate observation of material specimens in biology, physics, or chemistry.

Objections have been urged against introspection as a scientific method on the ground that its results cannot be verified. The claim has been made that the results of introspection cannot be confirmed because no one can observe directly the conscious states of another. On the other hand, the objects of material sciences are said to be common property. Any one may observe them and confirm the reports of others. This distinction of the *private nature* of consciousness and the *public nature* of objects is not as far-reaching as it seems at first sight. All the sciences are built up by means of observation. But every observation is the observation of some *one* person. The observation itself is always a private and personal affair. Different observations can be brought together and made to agree only when reduced to a common unit of measurement. By means of this unit of measurement uniformity may be established, and this is the most important thing in all observation. In the material sciences the uniformities are found in terms of units of quantity—the millimetre, the gram, et cetera. In psychology the uniformities are in the terms of quality—quality of experience. The units of quality are descriptive units, or language symbols. The facts of consciousness discovered by means of introspection may be reduced to the common terms of descriptive language. If when measured by these common terms the experiences of different observers show uniformity, that is sufficient verification.

Restating this point, we may say that the so-called material objects of the sciences always fall within some one's private experience. The material object which I observe is my object, and the material object which you observe is your object. You can never experience my object and I can never experience your object. They become common to both of us only when they are described in the same terms, *i. e.*, reduced to the same symbols. Likewise, my consciousness and your consciousness become common property when described and communicated through the medium of language. The reliability of these descriptions depends, of course, upon the degree of accuracy with which the symbols of language are used. There is, to be sure, greater opportunity for variation and error in the language description of psychical facts than in the quantitative units of measurement of the material sciences. But even in the material sciences there is variation and error. No two observers report exactly the same results from the observation of material objects. The method of introspection in psychology and the method of observation employed in the material sciences are alike in their fundamental procedure. They both reduce the results of individual and personal observation to the common terms of measurement or description, and by means of the uniformities discovered verify the facts. When a number of investigators co-operate and compare the results of their introspection, and repeat them again and again, a mass of cumulative evidence is obtained that is entirely trustworthy.

Another objection to introspection has been offered on the ground that the observation of mental states cannot take place without changing their nature. This objection is based upon the assumption that the consciousness of mental states is not the same as the consciousness of material objects. This assumption, as we have seen, is not well founded. We have spoken of this before, but let us remind ourselves again that the observation of mental states is not a different kind of observation from that by which we know the material world. The physicist interprets his experience in one way and the psychologist in another, *but the interpretation is a construction which is put upon the experience after it is over.* In the one case we are interested in the experience as an object belonging to an independent material world. In the other case we are interested in the experience as a part of *our* consciousness. At the moment of observation both the object and the mental state are given in our awareness.

The second form of observation in the procedure of psychology supplements introspection. It is the observation of behavior. From these external manifestations we may not only infer the presence of consciousness, but its nature. When a man smiles we judge that he is pleased. When a young child cries we know that it is experiencing pain. We can establish the fact that there is a large number of correspondences between the two series of events. Bodily movements and attitudes are the outward signs of conscious states. The quiver of the eyelid, the tremor of the muscles about the mouth, the faint blush upon the cheek, the peculiar quality and intonation of the voice, all betray to the practised observer the nature of the conscious states back of them. In young children and animals observation of behavior is the only means we have of gaining knowledge of their mental states.

**Consciousness.**—What consciousness ultimately is we do not know any more than we know what life ultimately is. Many theories have been formed about its *real* or intrinsic nature, but so far these theories have been of little value to the science of psychology.[1]

When the psychologist asserts his inability to define consciousness ultimately he does not intend to imply that psy-

[1] Such inquiry really belongs within the province of metaphysics and not in psychology. We may, however, note two opposing theories concerning the ultimate nature of consciousness that have been generally held:

1. The spiritualistic hypothesis.
2. The materialistic hypothesis.

The spiritualistic hypothesis holds consciousness to be states of an unextended permanent being of immaterial or spiritual nature. The materialistic chology is different from the other sciences in respect to the definition of its fundamental subject-matter. No science is able to define its subject-matter ultimately. What matter really is remains as great a mystery as ever, even though the sciences of physics and chemistry attempt to define it variously in terms of energy, or in terms of the atom, the ion, or the electron. These are metaphysical conceptions, and they tell us no more about the *real* nature of matter than the spiritualistic or the materialistic hypothesis tells us about the *real* nature of consciousness. Biology, too, is unable to define life ultimately, although it has been tempted into metaphysical speculation about it. This is illustrated by the attempt in some quarters to conceive life as a manifestation of "vital force"—a principle of mysterious and unfathomable essence thought to be the cause of life phenomena. Even the attempt to reduce life to some form of refined chemical reaction is none the less pure speculation. Just as the material and biological sciences have now given up speculation about the transcendental nature of matter and life, so psychology no longer speculates about the transcendental nature of consciousness.

While we are unable to reduce consciousness to anything more fundamental than itself, we are able to define it as observable fact. When we say that we are conscious we mean that we have experiences that we know directly. Every moment of our waking lives we are conscious: we see lights and colors, or hear sounds, or taste foods, feel pleasures or pains, perceive objects, image forms, remember past events, or form judgments, reason, feel glad or sad, or angry, love or hate, resolve, decide, and experience impulses to act. Any or all of these are states of consciousness. We can observe them directly. We can analyze those that are complex into

hypothesis regards consciousness as a form of nerve-energy which, so far, we have not been able to observe and measure. But whatever the metaphysical basis of consciousness may be, the facts of consciousness remain the same as far as observation of them goes.

simple conscious states and can weave them into a system of relationships.

Some of the earlier English psychologists used the term *consciousness* to signify awareness of one's own mental states and processes. Locke defined it as the "perception of what passes in a man's own mind," and Reed as "that immediate knowledge which we have of all the present operations of our own mind." But more recently that meaning has been discarded and now the term *consciousness* is used to indicate any and all mental experience; not only the awareness of our own mental states, but also awareness of objects and relations in the outer world; not only the mental experience of man but the mental experience of all sentient beings.

**Subject-Object Nature of Consciousness.**—One of the most troublesome points to keep clear in discussing the nature of consciousness is the distinction which we are logically forced to make between the subject side of consciousness and the object, or content, side. To be conscious implies some one who is conscious. To have a sensation or thought seems logically to involve a *subject* to which the sensation or thought is presented. What thinks the thought? What has and owns the sensation? Professor James's answer, "that the thoughts themselves are the thinkers," does not satisfy the logical need of *our* thinking. This question appears in various forms in the study of conscious phenomena. We cannot attempt really to answer it without entering the field of metaphysics, but psychology has the right to make any assumption concerning it that is in accord with the facts of consciousness. The spiritualistic hypothesis of consciousness assumes a being of psychical nature, a permanent ego, or knower, to which all consciousness as content is presented. This double aspect of consciousness has given rise to two different points of view concerning consciousness:

1. Consciousness as the act of the subject.
2. Consciousness as content of experience.

It is important for the student to keep clearly in mind these two possible meanings of consciousness, because in psychology the term is sometimes used in one sense and sometimes in the other, and often the meanings are confused. The first meaning considers only the subject and its activity in attending, perceiving, feeling, willing, et cetera. The second meaning considers only the content of experience, or, in common terms, that which is experienced—a sensation, a percept, a memory image, an emotion, et cetera. For example, the content of consciousness is that which is presented to us as different experiences. The experience of red is different from that of green. The experience of the taste of sugar is different from the experience of the sound of middle C on the piano. The experience of an emotion is different from the experience of a memory image. Such experiences make up the content of consciousness.

It is not possible in an introductory psychology to avoid the use of consciousness as subject and consciousness as content, but it is possible to know when we are using the one and when the other. As an illustration of the two meanings of consciousness found in the literature of psychology we may instance the widely differing definitions offered for some of the most common concepts. For example, if the student will read the definitions of *attention* in a number of text-books on psychology, he will find that in some attention is defined as the "power of the mind to concentrate, select, and prolong consciousness," while in others it is defined as "clearness, vividness, or distinctness of mental content, accompanied by a complex of muscular strain and effort." It is plain that in the former case consciousness is conceived as a subject or agent manipulating the contents of its experience, while in the latter case consciousness is merely content.

It is the content side of consciousness which furnishes the facts of scientific psychology, because the content of our experience is the only part of consciousness that lends itself to observation. It is the only part about which we can have definite, empirical knowledge. On the other hand, the so-called subject of consciousness always lies outside the world of observable facts. It is a logical construction which should be used in psychology only as a convenient hypothesis. In referring to the subject of consciousness as a logical construction, we mean that it is a factor which appears only after we begin to think about the facts of consciousness and attempt to explain them rationally. It is, therefore, a product of thought, and not a directly observable reality.

Those who have attempted to avoid the hypothesis of a spiritualistic subject of consciousness or have denied its existence, usually substitute for it the assumption that consciousness is really some form of nervous energy. They assert that there is no necessity of assuming anything more than this nervous energy in a living and acting brain to account for the phenomena of consciousness. Whether we accept the hypothesis of a psychical or spiritual subject of consciousness, or that of the material nature of consciousness, really makes little difference within psychology itself so long as we are consistent in holding to one or the other. The observable facts remain the same in either case. The sensation of red is just what it is experienced to be, whether it is referred to a psychical subject or to a form of nervous energy. If consciousness is a form of nervous energy, then the brain or nervous system is the unifying principle which has and owns the conscious states. Now, we know by actual observation that conscious states as content of experience exist only at the moment of their experience. Then, according to the materialistic conception, they become, when they cease to be experienced, merely states or conditions of the nervous system. They may be revived again when the nervous material which has given rise to them is stimulated into activity. This conception tacitly assumes a mode of transformation between material brain processes and conscious experience that is beyond the realm of observable fact. Even if it were possible to observe all the details of the brain-cell processes, and to follow them to their last chemical or physical activities, they would still be just what they are—material processes. The particular manner or mode of their transformation into conscious states is never revealed to us as observable fact. The central point in this materialistic hypothesis is the assertion that conscious states are really and ultimately some form of nervous energy in the brain, and that therefore the brain is the ultimate ground of existence for all consciousness.

The student should not confuse this assumption with the observable fact of the dependence of conscious phenomena upon the brain or nervous system in a living organism. The assumption attempts to explain the ultimate or real nature of consciousness by reducing it to nervous energy. On the other hand, the establishment of the fact of the dependence of consciousness upon the nervous system does not involve the question of what its ultimate ground of being is, but rests its case upon the observable facts of consciousness on the one hand, and the observable facts of brain states and activities on the other.

**Soul.**—In popular thought it is often the *soul* which plays the part of the subject of consciousness. Here we meet the idea that it is the soul that knows and feels and wills. But the popular conception of the soul really involves so many transcendental and metaphysical attributes that it cannot be used profitably in psychology. If the term is used at all there, as it oftentimes is, it must be shorn of many of its metaphysical implications and made identical with the mere subject of consciousness. The old and popular meanings are apt, however, to associate themselves with its use, even in a restricted sense. So it is better to avoid the term in psychology.[1]

Singularly enough the term soul has sometimes been used to signify the content side of consciousness. This conception makes it the sum total of one's thoughts and feelings. But this is altogether unjustifiable, because it twists the term

[1] It is a narrow and pedantic view which for this reason denies its existence as an ultimate reality.

too far from its popular and original meaning. Its use as the subject of consciousness is preferable, for then it retains some of its old meaning as a permanent being, or entity, behind our consciousness experiences.

**Mind.**—The double aspect of consciousness appears again when we try to get a clear idea of what is meant by *mind*. Very commonly it is used to designate that which owns the conscious states. Thus we speak of a sensation, a perception, an image, a feeling, or an emotion as in the mind, or we may say that the mind has the sensation, the perception, et cetera. In this way we think of the mind as a continuous, if not permanent, psychical being persisting through the varying states of consciousness and holding them together, and possessing powers, capacities, attributes, and dispositions which are always in existence, even when not active. Used in this sense, it turns out to be the same conception as that of the *subject* or *knower* of *consciousness*, and it is therefore metaphysical in its real meaning. In this sense the mind is that *something* that knows and feels and wills, but what that something is, is never given to us as an observable fact.

On the content side of consciousness *mind* is the sum total of all our mental states. Sensations, images, memories, judgments, feelings, desires, volitions, et cetera—all these organized, systematized, and unified in such a way that they hang together as an individual whole. This is the mind that we know directly. Since, however, the content of experience is known only in the present moment, and since each present-moment experience is in a way separate from all others, we might think at first glance that there could be no unity or organization in the contents of experience themselves, and that without a unifying *subject* the contents of consciousness would remain a mere series of isolated bits, strung out in a time sequence. In fact we very frequently find references to the *subject* of consciousness as that something, the *sole* function of which is to organize the various elements of our experience into some sort of unity. Without this something it is claimed that no organization or unity can exist. But the present moments of experience do contain actual and observable material which binds them together. For instance, if I recognize a man to-day whom I met last week, the present moment of consciousness has in it not only the presentation of the man to-day, but the memory of the man last week. Thus the present-moment experience has in it as a part of its content the element of memory which binds it to the past experience. Recognition is present in the sensory presentation of the man to-day as a consciousness of familiarity which relates the present content to past content. In a full and complete recognition there is consciousness of the identity in the two experiences, and of the time relationship between them. Moreover, the two experiences fall within a larger and relatively unchanging content which we shall discuss later as the self. This larger content is always involved in any single experience incorporating it within a system of conscious relationships. Therefore, no single experience stands by itself even on the content side of consciousness. While the experiences appear to come to the individual in a series of sequences, they really interpenetrate each other and form an organized continuum.

**Self.**—On the subject side of consciousness *self*, *mind*, and *subject* are really synonymous terms. The subject self is that which persists through all the changing experiences of the individual and is therefore the psychical being to which all these experiences are presented. Like the mind, it is supposed to possess powers, capacities, attributes, and dispositions which account for its outward and observable characteristics and manifestations.

But on the content side of consciousness the *self* is the most central, intimate, and persistent core of experience of an individual—those experiences which form the complex mass of conscious content not always directly attended to, but subconsciously present; that content which changes slowly but grows and develops as we become more familiar with our own nature and the world about us. It is made up of our bodily sensations and sensuous appetites, our private feelings and insistent memories, our real desires and familiar thoughts and ideas. These elements are not all present at any one moment, but change with the changes of our daily life. The organic or bodily sensations and feelings are, however, fairly constant, and form a relatively permanent centre about which the other self-contents revolve. Sometimes one and sometimes another group of experiences combines with this constant factor of bodily sensations, and thereby makes up the changing aspects of the self. The business man leaves his family self behind and puts on another self when he enters upon the duties of the day. He passes from one set of habitual and familiar background experiences to another. He shows a different side of his character at the club, on the golf-links, or at an evening reception. Yet there is a certain identity running through these different groups of self-experiences which unifies them into a single system of experience. Certain of these experiences are more persistent than others, and form a background against which all new experiences are projected.

Although, as we have seen, the terms *mind* and *self* point out the same ultimate reality, as subject of consciousness, they are used with different meanings or restrictions. As far as the naïve metaphysics of psychology go there is practically no differentiation between the mind and self. They are both the subject which knows and feels and wills, and whatever powers and attributes are assumed for the one are usually attributed to the other. But on the content side of consciousness there is a definite limitation. *Mind* is an organization and unity of conscious content in an individual, while *self* is a central group within the larger organization of the mind.

The preceding discussion has made plain the fact that there are two distinct tendencies in psychology—the philosophical and empirical. The one leads us into the world of speculation and metaphysical reality. The other limits us to the world of observable facts. The one induces us to infer and believe in the existence of an enduring ego, mind, or soul. The other deals only with the observable content of consciousness. The one appeals to our interest in the larger problem of the ultimate reality and meaning of our experiences. The other limits us to an arbitrarily chosen field of facts—the facts of consciousness which are abstracted only for the purpose of study. While it is our desire to follow the empirical tendency, it is not our intention thereby to take away, or even to diminish the student's interest in the question of the ultimate nature of consciousness. What consciousness really is, how it came to exist, and what its place is in the universe—are questions worthy of our higher reason and philosophical insight. No petty round of facts ought to ensnare and tame man's desire to know the whole truth. We believe that the world is larger than the facts given us by the methods of science. *But before we attempt to take the broader outlook, our first task is to master the facts just as they are given to us*—to pick out those that are significant and to analyze them into their elements and find out the laws that govern their behavior, to evaluate them properly and organize them into a system. This is the task that empirical psychology sets before itself.

In a general study of human consciousness such as we are going to undertake there are several points of view to be kept in mind:

1. Conscious states must be analyzed and described. In doing this we take the structural point of view and ignore the functional aspect of consciousness.

2. We must point out the laws of mental activity according to which conscious states conjoin and form streams of thought or feeling. Here consciousness is considered as a process and the point of view is functional.

3. The relation of consciousness to the brain and its nerve processes should be determined. When we attempt to do this our point of view is physiological.

4. Changes in consciousness that accompany changes in the physical world which act as stimuli should be noted. This demands the psychophysical point of view.

5. Finally we must not neglect the relation of consciousness to behavior.

We shall not attempt to follow these points of view separately. Sometimes one and sometimes another will be uppermost in the following discussions.

## CHAPTER II

### THE NERVOUS SYSTEM

Although the study of the structure and function of the nervous system is not properly a part of psychology, it is, nevertheless, important for the understanding of the processes of conscious life to know something of the elementary facts in the anatomy, histology, and physiology of the brain. This seems necessary since we assume that all consciousness is in some way dependent upon the action of the nervous system.

The brain is connected through nerve-fibres with all parts of the body. Some of these fibres (sensory fibres) come from the sense end-organs which are played upon by the external forces in the environment, and some of them (motor fibres) go out to the muscles which bring about adaptive movements of the body. Biologically the brain and its nerve-connections are merely the means through which external stimulations are transformed into organic behavior. Changes in the outer world act upon the sensory nerve-ends and set up nerve-impulses which are carried to the brain, where they are projected outward into appropriate muscular and glandular activities.

But accompanying these physiological brain and nerve processes there is something else which is not discoverable in them, and of which physiology can take no account, however much its methods may be refined and perfected. This something is *consciousness*. When light-rays strike the retina we *see*. When air-vibrations enter the ear we *hear*. Besides the sensations which arise when external objects stimulate the sensory end-organs there are other conscious experiences which accompany the neural processes within the brain. These experiences are the higher conscious states of perception, imagination, memory, judgment, reason, feelings, emotions, etc. Although conscious states depend upon brain states, we must not confuse these two forms of existence—the mental and the physical. Consciousness is not the brain, or any of its neural processes. Even though we were able to follow and observe a nerve-activity to its last analysis within the brain-cells, we could never discover an element of consciousness in it. What the exact relation between the mind and the brain is we do not know. We can only assert that the mind is dependent upon certain brain-activities.

**Consciousness and the Nervous System.**—There are several groups of facts which indicate the dependence of consciousness upon the nervous system:

1. Consciousness depends upon the action of sense-organs. Without the sensitive nerve-endings in eye, ear, nose, mouth, skin, and deeper tissues of the body, we could never be aware of anything. All the higher forms of consciousness are based upon the sensory experiences which are mediated by the nerve-endings in the sense-organs.

2. Certain drugs, like alcohol, ether, hashish, etc., which disturb the action of the nervous tissue in the brain, also affect consciousness.

3. Bodily diseases, especially those producing high fever, seriously interfere with the conscious processes.

4. Diseased conditions of the brain—tumors, brain-hemorrhages, lesions, disintegration of the nervous tissue, etc., are followed by disturbances or loss of certain forms of consciousness. Thus a tumor in the occipital region of the brain may cause the loss of visual memories. A lesion in the left temporal lobe is followed by the loss of the ability to understand spoken words.

5. If we compare the different forms of animal life, from the lowest to the highest, we find that the most highly developed consciousness goes with the most complex and highly developed nervous system.

**Development of the Central Nervous System.**—The central nervous system is made up of the *brain* and the *spinal* *cord.* The brain is the mass of nerve-tissue found within the cranial case, while the spinal cord is the long tube of nervous tissue within the vertebral canal. The brain sends out twelve pairs of cranial nerves whose fibres go to the sense-organs and muscles of the head, face, and some of the vital organs of the body. From the spinal cord issue thirty-one pairs of spinal nerves whose fibres go to the sensory surfaces and muscles of the body. The cranial and spinal nerves are composed of sensory and motor fibres which constitute the afferent and efferent pathways between the body and the central nervous system.

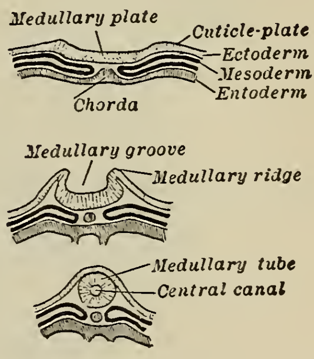



FIG. 1.—Diagram representing the formation of the medullary tube from the outer germ-layer.

(Taken from Villiger's "Brain and Spinal Cord.")

We can best understand the structure of the nervous system by following its embryological growth. Nerve-tissue develops from the ectoderm or outer layer of embryonic cells. Very early in the growth of the embryo, after it has elongated, a longitudinal groove, the medullary groove, forms in the medullary plate, or beginning nerve-tissue. The edges of this groove come together and form the *neural tube*, which extends along the length of the vertebral column and into the cranial cavity.

The cavity enclosed within the neural tube is the spinal canal. This canal, at its upper extremity, later forms the irregular ventricles of the brain. The walls of the upper, or anterior part of the neural tube thicken enormously and form the brain. The walls of the lower part thicken to a less degree but more uniformly and form the spinal cord. Within the cranial cavity the neural tube forms by ring-like constrictions and dilatations into three primary brain vesicles, known as anterior, middle, and posterior vesicles. These three primary vesicles give rise to the fore-brain, mid-brain, and hind-brain respectively.

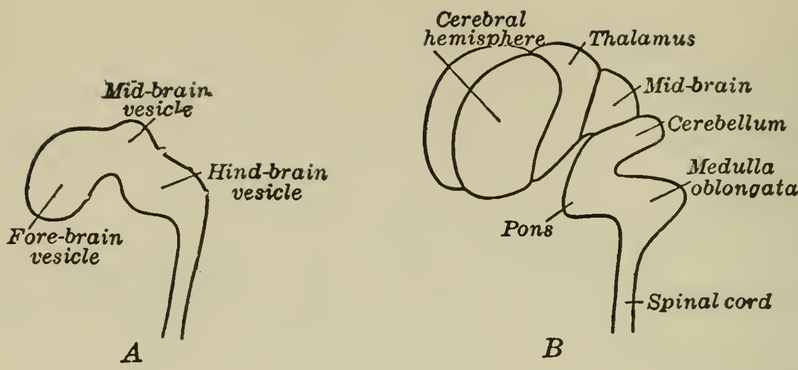



FIG. 2.—*A*, Diagram showing the brain-vesicles; *B*, Diagram showing parts of embryonic brain

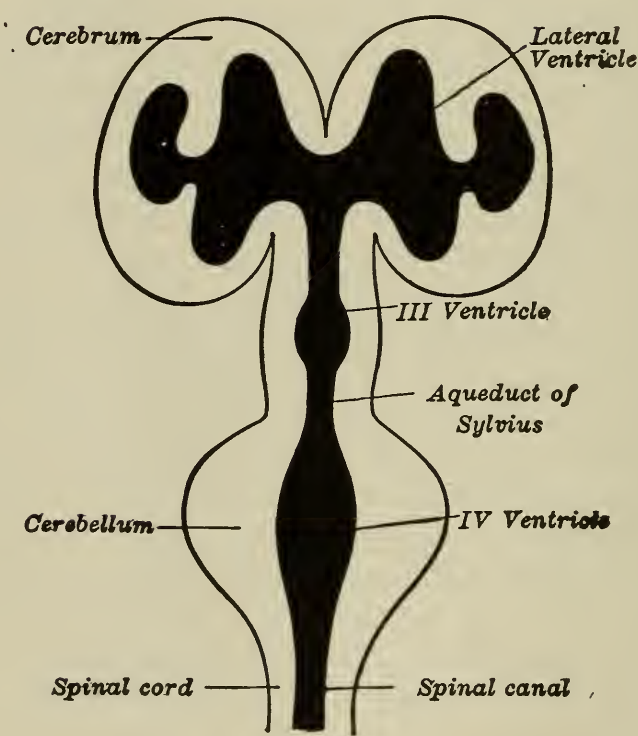



FIG. 3.—Diagram showing the brain-ventricles

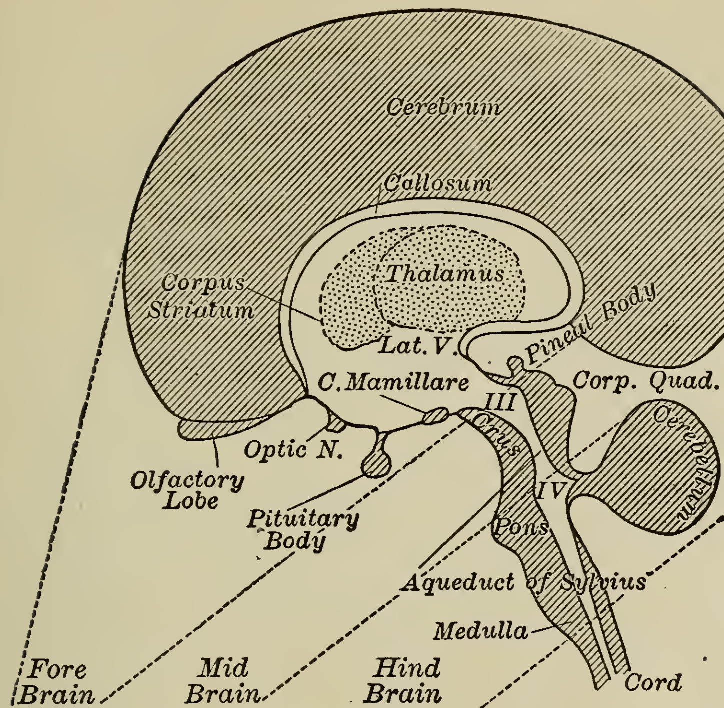



FIG. 4.—Diagram showing a cross-section of the brain. (Highly diagramatic.)

| | | | |
|---|---|---|---|
| Neural tube | Fore-brain | Anterior | Olfactory bulbs and tracts.<br>Cerebral hemispheres.<br>Corpora striata.<br>Lateral ventricles. |
| | | Posterior | Pineal body.<br>Thalami.<br>Optic tracts.<br>Third ventricle. |
| | Mid-brain............ | | Corpora quadrigemina.<br>Crura cerebri.<br>Aqueduct of Sylvius. |
| | Hind-brain............ | | Pons Varolii.<br>Medulla oblongata.<br>Cerebellum.<br>Fourth ventricle. |
| | Spinal cord. | | |

**The Gross Structure of the Brain.**—The brain is divided by a median fissure into two symmetrical hemispheres. The division is not complete, however, for at the bottom of the fissure a broad band of fibres, the *corpus callosum*, unites the two halves of the brain. The median fissure extends the whole length of the cord and divides it less prominently into right and left halves.

The surface of the brain is furrowed by *fissures* or *sulci*, which serve to increase the cortical area. The ridges between the fissures are called *convolutions*. Two of the fissures, deeper than all the others, make convenient landmarks on each cerebral hemisphere. They are the *lateral fissure* (fissure of Sylvius) and the *central fissure* (fissure of Rolando).

It is sometimes convenient to divide each cerebral hemisphere into lobes. The *frontal lobe* occupies the anterior, the *occipital lobe* the posterior, the *parietal lobe* the upper central, and the *temporal lobe* the lower central part of the cerebral hemisphere. The island of Reil forms the fifth lobe of the cerebral hemisphere.

The *cerebellum*, sometimes called the little brain, lies below the cerebrum on the dorsal side of the brain. Below and in front of the cerebellum is the *medulla oblongata*, which is an enlargement of the *spinal cord* at its upper end. Almost encircling the medulla oblongata is the *pons*, a thick band of fibres joining the two halves of the cerebellum.

The cerebral hemispheres are the largest and most conspicuous parts of the fore-brain. The other principal parts, the *corpora striata*, the *pineal body*, and the *thalami*, are overlaid and concealed from view by the folds of the cerebral hemispheres. The hemispheres also enfold the parts of the mid-brain, the *corpora quadrigemina*, and the *crura cerebri*, which lie below the thalami. The pons, medulla, mid-brain, and thalami constitute the *brain-stem*. A medial cross-section of the brain will show all these parts except the corpora striata.

From the ventral and basal side of the brain are given off

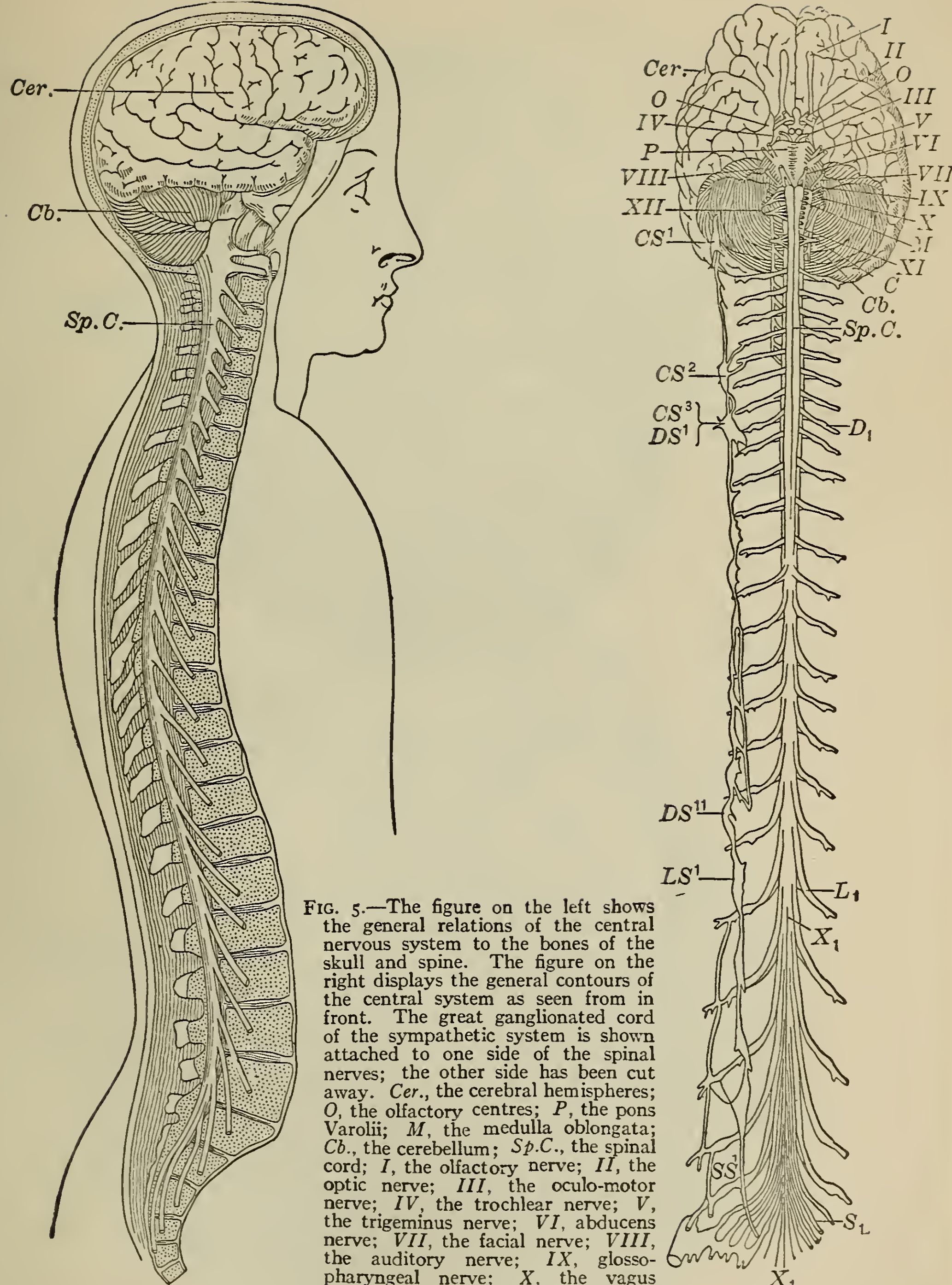



FIG. 5.—The figure on the left shows the general relations of the central nervous system to the bones of the skull and spine. The figure on the right displays the general contours of the central system as seen from in front. The great ganglionated cord of the sympathetic system is shown attached to one side of the spinal nerves; the other side has been cut away. *Cer.*, the cerebral hemispheres; *O*, the olfactory centres; *P*, the pons Varolii; *M*, the medulla oblongata; *Cb.*, the cerebellum; *Sp.C.*, the spinal cord; *I*, the olfactory nerve; *II*, the optic nerve; *III*, the oculo-motor nerve; *IV*, the trochlear nerve; *V*, the trigeminus nerve; *VI*, abducens nerve; *VII*, the facial nerve; *VIII*, the auditory nerve; *IX*, glosso-pharyngeal nerve; *X*, the vagus nerve; *XI*, spinal accessory; *XII*, the hypoglossal nerve; *C*, the first cervical spinal nerve; $D_1$, the first dorsal, or thoracic, nerve; $L_1$, the first lumbar nerve; $S_1$, the first sacral nerve; $X_1$, filum terminale; $CS^1$, superior cervical ganglion of the sympathetic; $CS^2$, middle cervical ganglion of the sympathetic; $CS^3$, and $DS^1$, junction of the inferior cervical and the first dorsal, or thoracic, ganglion of the sympathetic; $DS^{11}$, the eleventh dorsal, or thoracic ganglion, of the sympathetic; $LS^1$, the first lumbar ganglion of the same system; $SS^1$, the first sacral ganglion also of the sympathetic

(From Angell's "Psychology.")

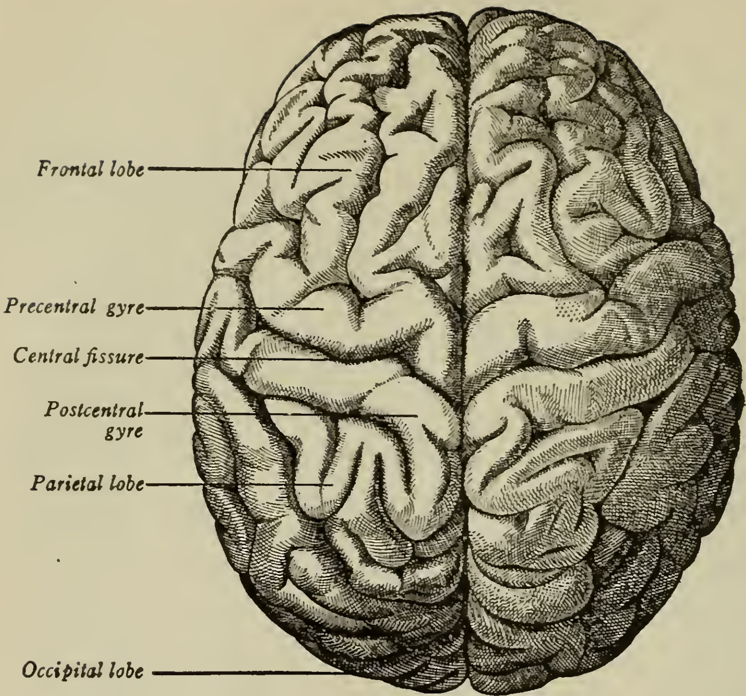



FIG. 6.—The upper surface of the cerebral hemispheres.
(From Ladd and Woodworth, after Sobotta-McMurrich.)

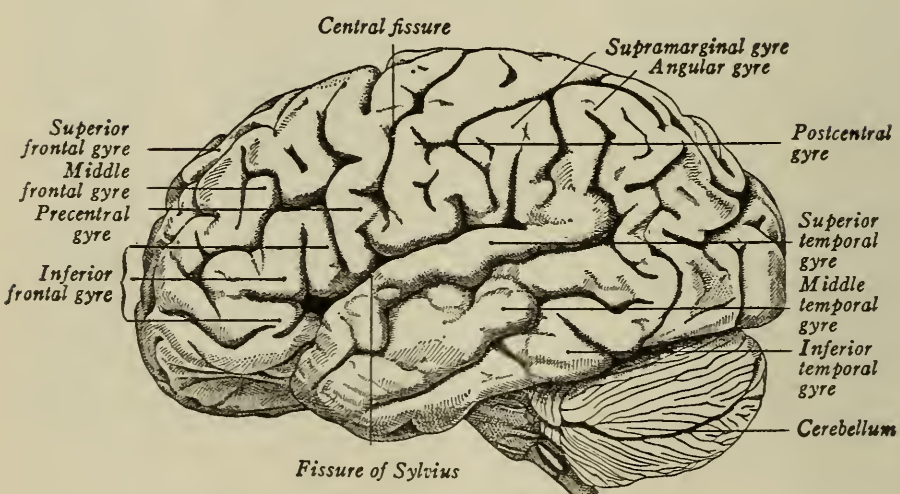



FIG. 7.—Lateral surface of the left cerebral hemisphere.
(From Ladd and Woodworth, after Edinger.)

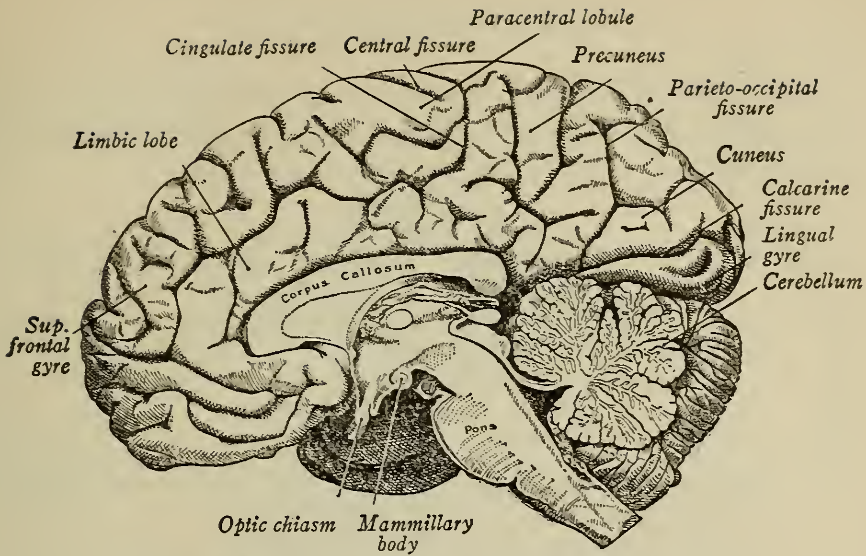



FIG. 8.—Mesial surface of the right cerebral hemisphere. (From Ladd and Woodworth, after Edinger.)

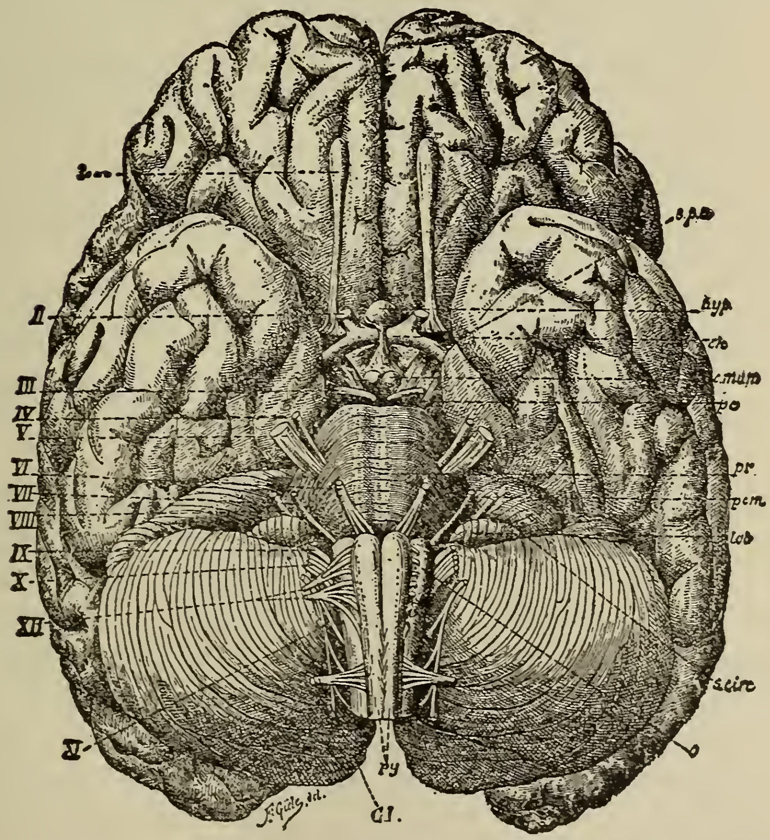



FIG. 9.—Under surface of the brain. (From Ladd and Woodworth, after Van Gehuchten.) The Roman numerals at the left margin of the figure indicate the twelve cranial nerves; *hyp*, hypophysis; *ch*, optic chiasm; *c. mam.*, mammillary body; *pc*, peduncle of the cerebrum; *pr*, pons; *o*, olive; *py*, pyramids; *CI*, first spinal nerve.

the twelve pairs of cranial nerves. Some of these nerves carry only sensory fibres, some only motor fibres, while others carry both sensory and motor fibres (mixed nerves).

### NAMES AND GENERAL FUNCTION OF THE CRANIAL NERVES

I. *Olfactory:* Sensory fibres from olfactory sense-organs.
II. *Optic:* Sensory fibres from the visual sense-organs.
III. *Oculo-motor:* Motor fibres to several muscles of eyes.
IV. *Trochlear:* Motor fibres to superior oblique muscles of eyes.
V. *Trigeminal:* Sensory fibres from cutaneous sense-organs of face, scalp, mouth, tongue, and teeth.
Motor fibres to muscles of mastication.
VI. *Abducens:* Motor fibres to external rectus muscles of eyes.
VII. *Facial:* Sensory fibres from gustatory end-organs in tongue.
Motor fibres to muscles of face, scalp, and external ears.
VIII. *Auditory:* Sensory fibres from auditory end-organs in cochlea (cochlear branch), and from semicircular canals of ear (vestibular branch).
IX. *Glossopharyngeal:* Sensory fibres from gustatory end-organs.
Motor fibres to tongue and pharynx.
X. *Pneumogastric, or vagus:* Sensory fibres from respiratory, circulatory, and digestive organs.
Motor fibres to pharynx, larynx, œsophagus, stomach, respiratory organs, and intestines, also inhibitory fibres to heart.
XI. *Spinal-accessory:* Motor fibres to muscles of neck and shoulders.
XII. *Hypoglossal:* Motor fibres to muscles of tongue.

The *spinal nerves* (31 pairs) are given off from the sides of the spinal cord. Each nerve is attached to the cord by two roots—a posterior root and an anterior root. The posterior root is composed chiefly of sensory fibres from cell-bodies in the spinal ganglia. The anterior root is composed of motor fibres whose cell-bodies lie within the gray matter of the cord. The two roots join shortly after leaving the cord and form a complete spinal nerve. The spinal nerves are divided into cervical (8 pairs), thoracic (12 pairs), lumbar (5 pairs), sacral (5 pairs), and coccygeal (1 pair).

The brain, the cord, the cranial nerves, and the spinal nerves make up the *cerebro-spinal nervous system.*

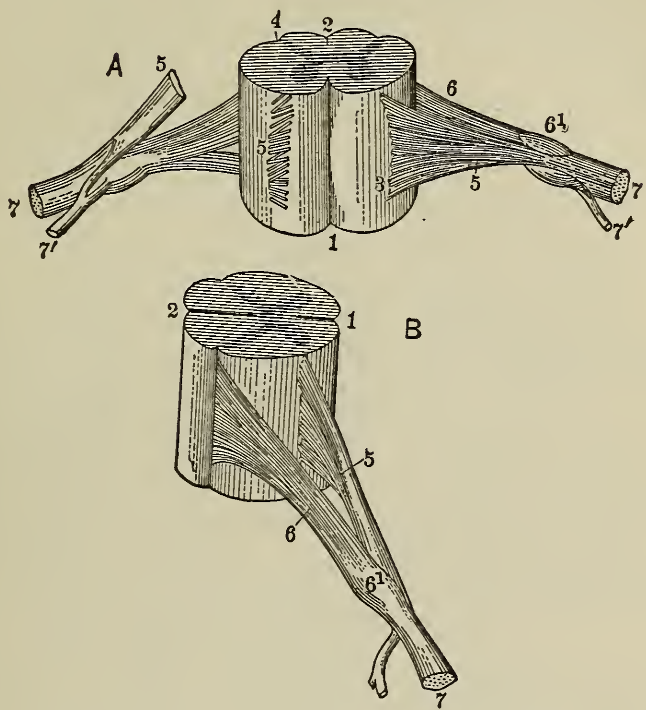



FIG. 10.—*A*, ventral, and *B*, lateral, view of a portion of the cord from the cervical region. 1, ventral median, and 2, dorsal median, fissures; 5, ventral fibres leaving the cord; 6, dorsal fibres entering the cord; $6^1$, spinal ganglion; 7, spinal nerve after the union of the dorsal and ventral fibres.

(From Ladd and Woodworth, after Schwalbe.)

**The Autonomic Nervous System.**—Besides the cerebro-spinal nervous system there is another relatively independent nervous system known as the *autonomic nervous system.* This is composed of a double chain of nerve-ganglia and nerve-fibres extending on both sides of the vertebral column from the base of the skull downward to the end of the column. In addition there are nerve-ganglia in the thoracic, abdominal, and pelvic cavities; also isolated ganglia located in the heart, in the walls of the arteries, and in the eye-cavities. While the autonomic system is connected with the cerebro-spinal ner-

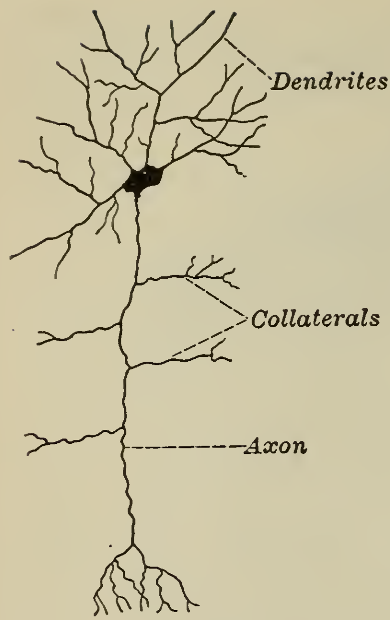



FIG. 11.—Nerve-cell from the cerebral cortex.

vous system, it is a relatively independent and self-directing system. It is due to its action that the vital and automatic processes of respiration, circulation, digestion, and the glandular processes are carried on without burdening the central nervous system.

**Nerve-Cells.**—The nervous system is composed of millions of nerve-cells too small to be seen except by the aid of a powerful microscope. The nerve-cell is composed of a protoplasmic *cell-body* and its prolongations or fibres. These prolongations are of two kinds: *axons* and *dendrites*. The whole nerve-cell (cell-body, axon, and dendrites) constitutes a nervous unit known as the *neurone*. Each cell-body gives off many dendrites, but in most cases only a single axon. The axon is smooth and regular in contour and preserves the same diameter throughout its course. It ends in a brush or terminal arborization. In some cases it gives off, along its course, branches or collaterals, and these end also in terminal arborizations. Axons vary greatly in length. While those which terminate within the brain are short, those which lead to outlying parts

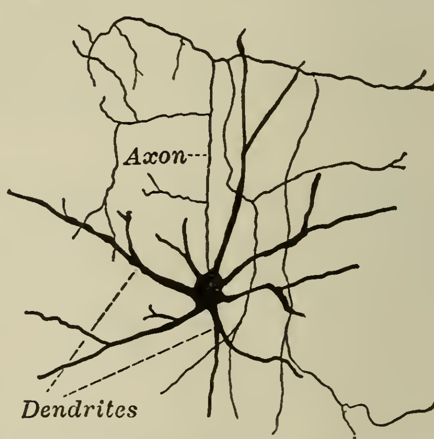



FIG. 12.—Multipolar nerve-cell from the cerebral cortex. In a cell of this type the axon is short and has many branches.

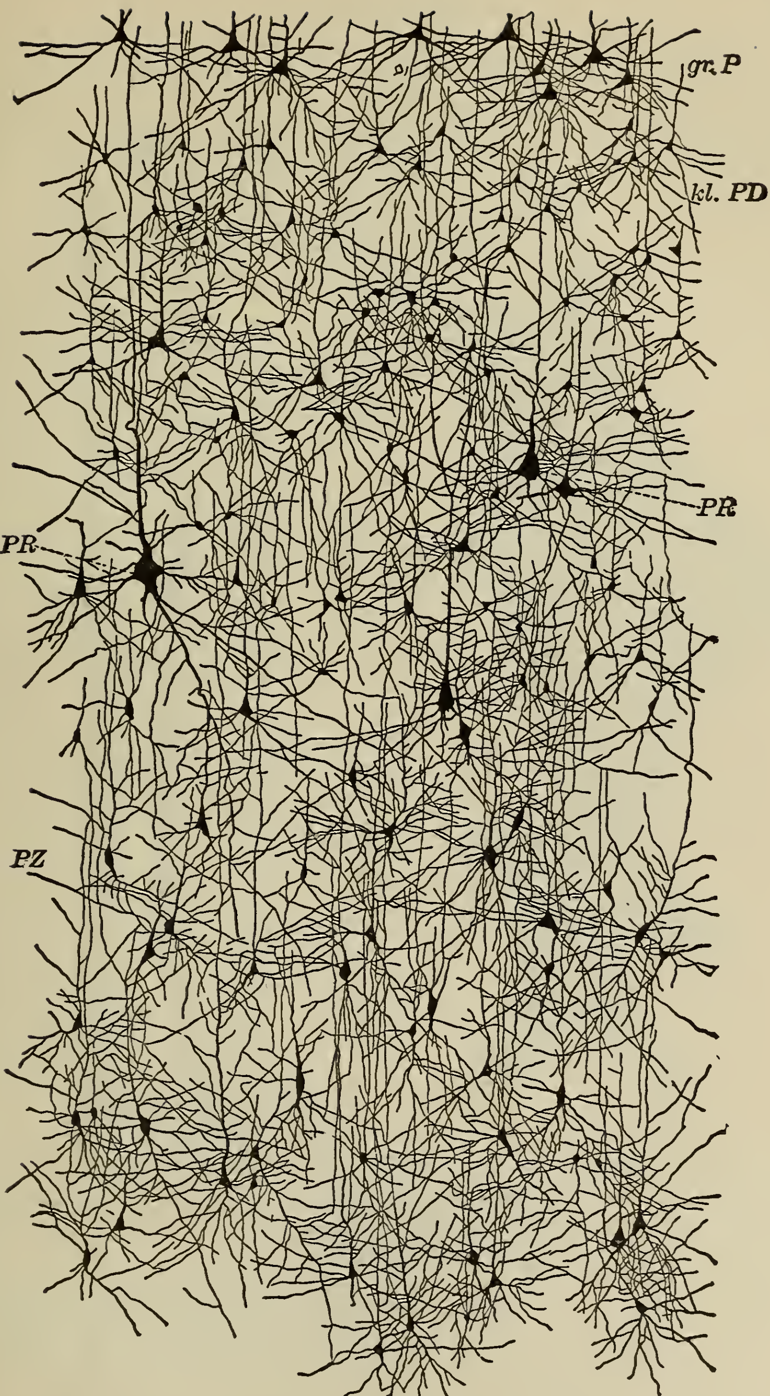



FIG. 13.—A section through the brain cortex. Greatly magnified.

(From Thorndike's "Elements of Psychology," after Kölliker.)

may be half the length of the body. The true nerve substance of the axon (the axis cylinder) is protected by a medullary sheath which disappears near the cell-body and at

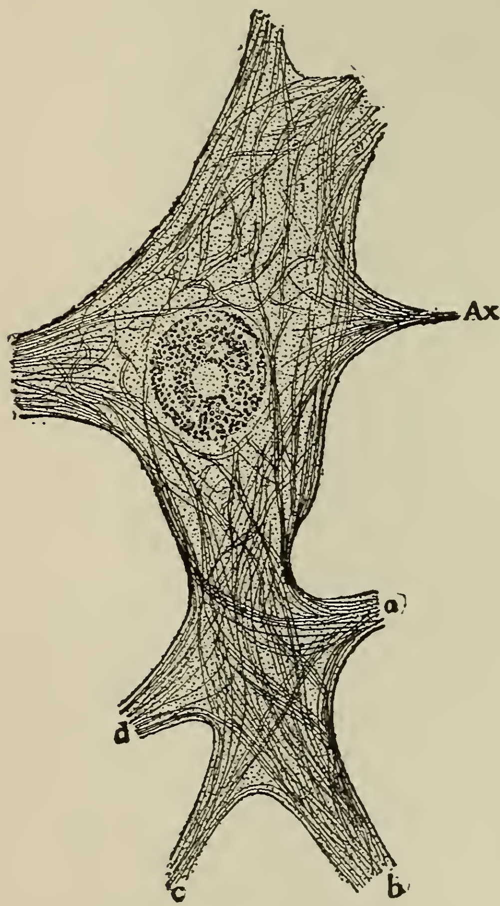



Fig. 14.—Nerve-cell showing fibrils. (From Ladd and Woodworth, after Bethe.) *a*, *b*, *c*, *d*, the stumps of several dendrites; Ax, stump of the axon.


Fig. 15.—Short pieces of two nerve-fibres. (From Ladd and Woodworth, after Schäfer.) The axis cylinder appears gray; the myelin sheath is stained black; the primitive sheath appears white. *R*, node of Ranvier; *c*, the nucleus of one of the sheath-cells.

the terminals of the axon. Outside the medullary sheath is usually found a thin covering known as the neurilemma. The dendrites are rough and branch more gradually from

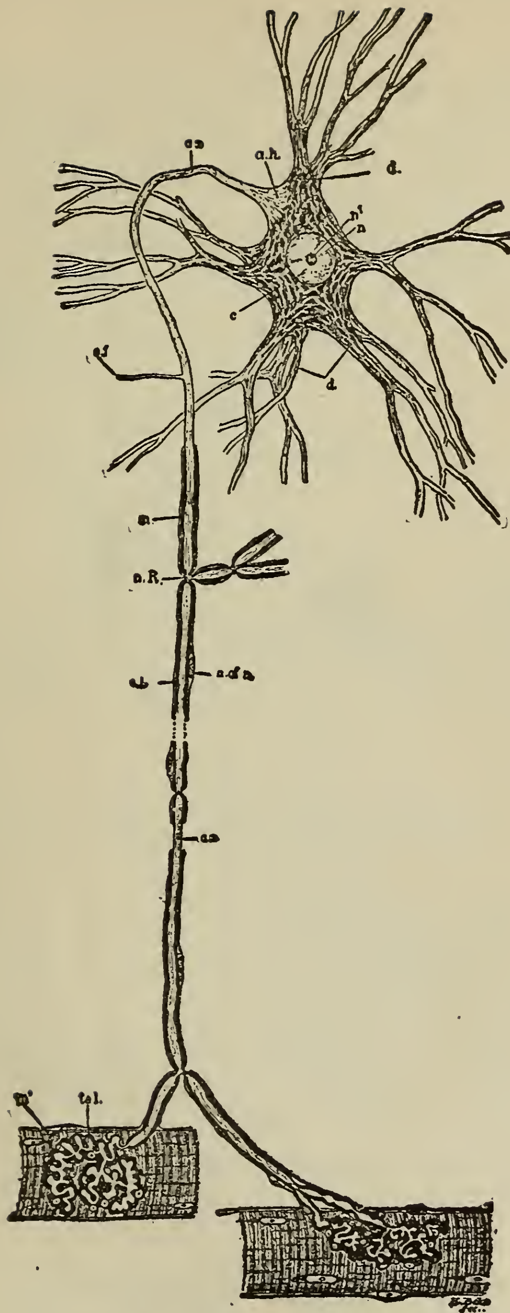



FIG. 16.—Motor-cell from the ventral horn of the cord, with scheme of the course of its axon. (From Ladd and Woodworth, after Barker.) *n*, the nucleus, with $n^1$, nucleolus; *d*, dendrites, only the stumps of which are shown; *a.h.*, hillock from which the axon arises; at *m*, the axon becomes invested with the myelin sheath; *n.R.*, a node with branching of the axon; $m^1$, a muscle in which the axon terminates in *tel.*, the motor end-plate.

each other, giving off antler-like processes. The size of the dendritic processes becomes rapidly smaller as they leave the cell-body. The nerve-cells are supported and held in place by neuroglia-cells whose numerous processes form a frame work in which the true nerve-cells rest.

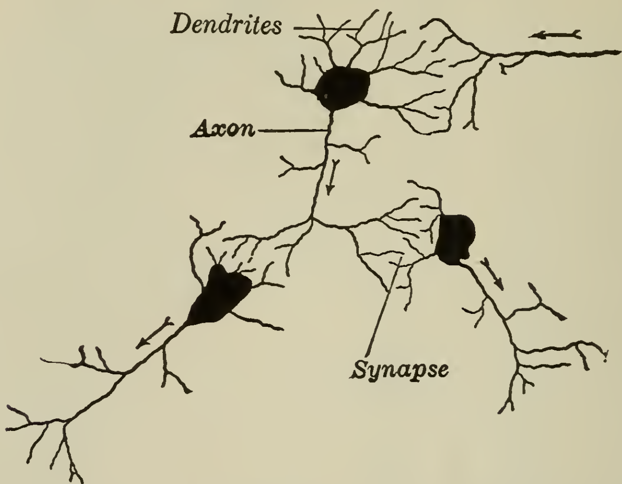



FIG. 17.—Diagram showing the probable way in which neurones are connected.

The function of the cell-body seems to be that of reinforcing and inhibiting the nerve-impulses which pass through it. The dendrites carry the impulses to the cell-body and the axon transmits the impulse away from the cell-body—to the dendrites of other neurones or to the glands and muscles of the body. There is one exception to this rule. The fibres which carry sensory impulses from the different sense-organs to the cell-bodies in the spinal ganglia resemble axons in structure.

How the nervous impulse is transmitted from one neurone to another is not definitely known. Many investigators believe that each neurone is a distinct individual unit, and that where neurones form a functional chain, the axonic terminals of one neurone merely approach the dendrites or cell-body of the next neurone. These points of contact or contiguity between neurones over which the nerve-impulse is passed from one to the other are called *synapses.* Since the axons and dendrites have many branches, the terminations of one

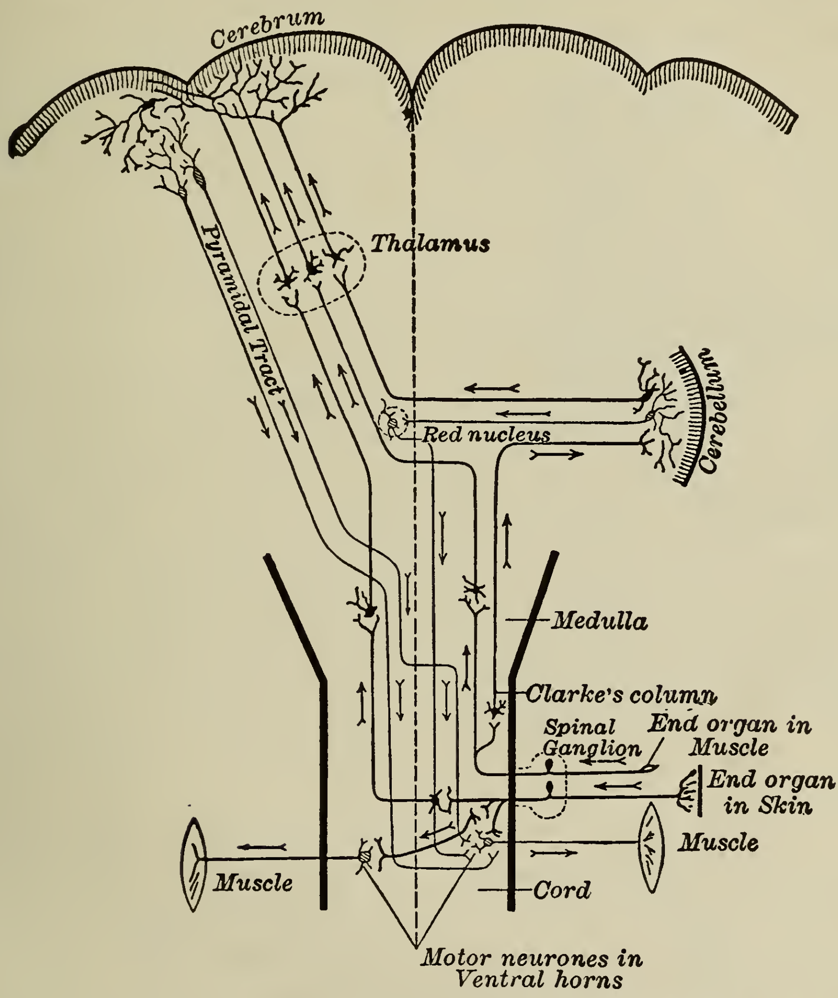



FIG. 18.—Diagram of some of the connections between sense-organs and muscles through ˍ ˒ cord and brain.

The student should understand that this diagram is far too simple to represent all the facts of nerve-connections.

axon may connect with the dendrites of a number of other neurones. Thus an impulse may spread to large areas of the brain and under different conditions take different pathways through the cord and brain. A single fibre from the spinal ganglion makes connections with fifty or sixty different neurones in the gray matter of the cord.

**Nature of the Nervous Impulse.**—Just what the nature of the nervous impulse is we are not able to say. The most popular theory regards it as a form of chemical activity analogous to the action in a train of gunpowder, which when lighted at one end transmits the combustion throughout its entire course. It has been suggested, also, that the nervous impulse is electrical in nature. But the rate of nerve transmission (not more than 300 feet per second) is much too slow for that of any known electrical action.

**Kinds of Neurones.**—Neurones may be classified according to their function into (1) *sensory or afferent neurones*, (2) *motor or efferent neurones*, and (3) *associational or central neurones*. The sensory neurones receive stimulation from the outside world and conduct sense-impulses to the sensory centres of the brain. The motor neurones project impulses outward from the brain to the muscles and glands. The central neurones form chains for connecting the different parts of the brain, as for instance from the sensory to the motor areas. When neurones pass from one-half of the brain or cord to the other half they are spoken of as *commissural neurones*.

The cell-bodies of the central and motor neurones lie within the brain and spinal cord, while the cell-bodies of the sensory neurones are found near the sense-organs or in the spinal ganglia outside the brain and cord. When a large number of cell-bodies are grouped closely together the group is spoken of as a ganglion.

The separate nerve-fibres are (except at their terminals) bound together in bundles or *nerves*. They are referred to as medullated and non-medullated nerves, according as the fibres which compose them are medullated or non-medullated.

**White and Gray Matter.**—The white matter of the brain, cord, and nerves is made up of medullated nerve-fibres. It is the medullary sheath which gives the whitish appearance. The gray matter is the true nerve substance and is found in the cell-bodies and in the fibres. In the medullated fibres the true nerve substance is hidden from view. The gray substance comprises the cortex or outer layer of the brain, certain ganglia within the brain, and the central core of the spinal cord. The entire outer surface of the brain is covered with a layer of gray matter (cell-bodies and unmedullated fibres) properly protected from the bony tissue of the skull by three membranes—the *dura mater*, the *arachnoid*, and the *pia mater*. The corpora striata, thalami, corpora quadrigemina are also composed of masses of gray matter. In the medulla and other parts are found smaller masses of gray matter called *nuclei*. The white matter of the brain is made up of the bands and bundles of medullated nerve-fibres connecting the cortex and the lower brain ganglia. The white matter in the cord (the outer layers) is made up of medullated fibres passing to and from the brain.

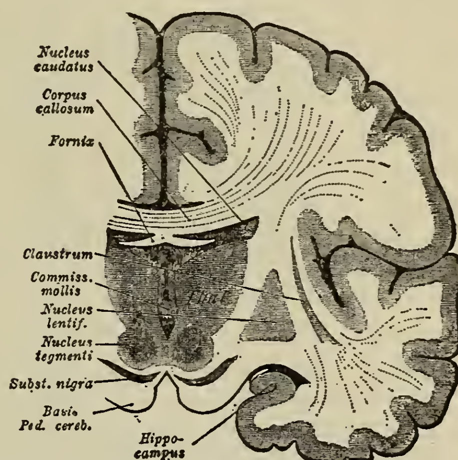



FIG. 19.—Frontal section through the cerebral hemispheres.

(From Ladd and Woodworth, after Gegenbaur.)

The shaded portions represent the cortex and ganglia (gray matter). The light portions represent the mass of medullated fibres within the brain (white matter).

The true nerve substance possesses two chief characteristics—*irritability* and *conductivity*. By irritability is meant the capacity to respond to stimulation by some kind of nerve process, and by conductivity the capacity to pass the nerve impulse from one point to another. The impulse is carried from dendrites to axon through the cell-body. The cell-body possesses the power to modify the impulses by reinforcing or inhibiting them. The direction which an impulse takes through the brain is determined by the condition of the synapses at the moment, and this is determined by the modifications of the brain tissue handed down through heredity and by those made by the past experiences of the organism.

**The Fibre Connections of the Brain.**—The medullated fibres which constitute the great nerve tracts of the brain and cord may be considered under three groups: (1) *Projection fibres*, (2) *association fibres*, (3) *commissural fibres*.

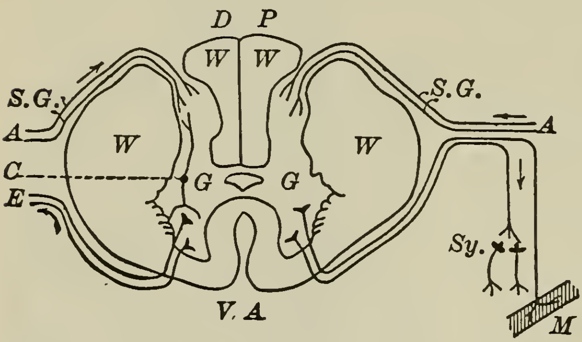



Fig. 20.—Diagrammatic cross-section through the cord showing gray and white matter. *WW*, white matter or medullated fibres; *GG*, gray matter; *A*, afferent sensory fibres passing through *S. G.*, the spinal ganglion, into the posterior horn of the gray matter; *E*, efferent motor fibres, most of which lead to muscles like *M*, many of which connect with the sympathetic ganglia, like *Sy; C*, central cell, probably traversed as a rule by impulses passing from *A* to *E; DP*, dorsal, or posterior, surface of cord; *VA*, ventral, or anterior, surface.

(From Angell's "Psychology.")

(1) The *projection fibres* join the cortex with the lower brain centers and with the spinal cord. These fibres bring in impulses from the sense-organs and send out impulses to the muscles. Those that bring in the sensory impulses are called the *ascending fibres*, while those that send out the motor impulses are called the *descending fibres*.

The descending fibres are axons from the motor neurones in the cerebral cortex. Of these fibres those which go to the nuclei of the cerebral nerves are known as *geniculate fibres*. As they pass downward into the lower brain they cross over to the opposite side, and there in the nuclei of the motor cerebral nerves communicate with the neurones which go to the muscles of the head and neck. The other descending fibres from the cerebral cortex communicate with the motor

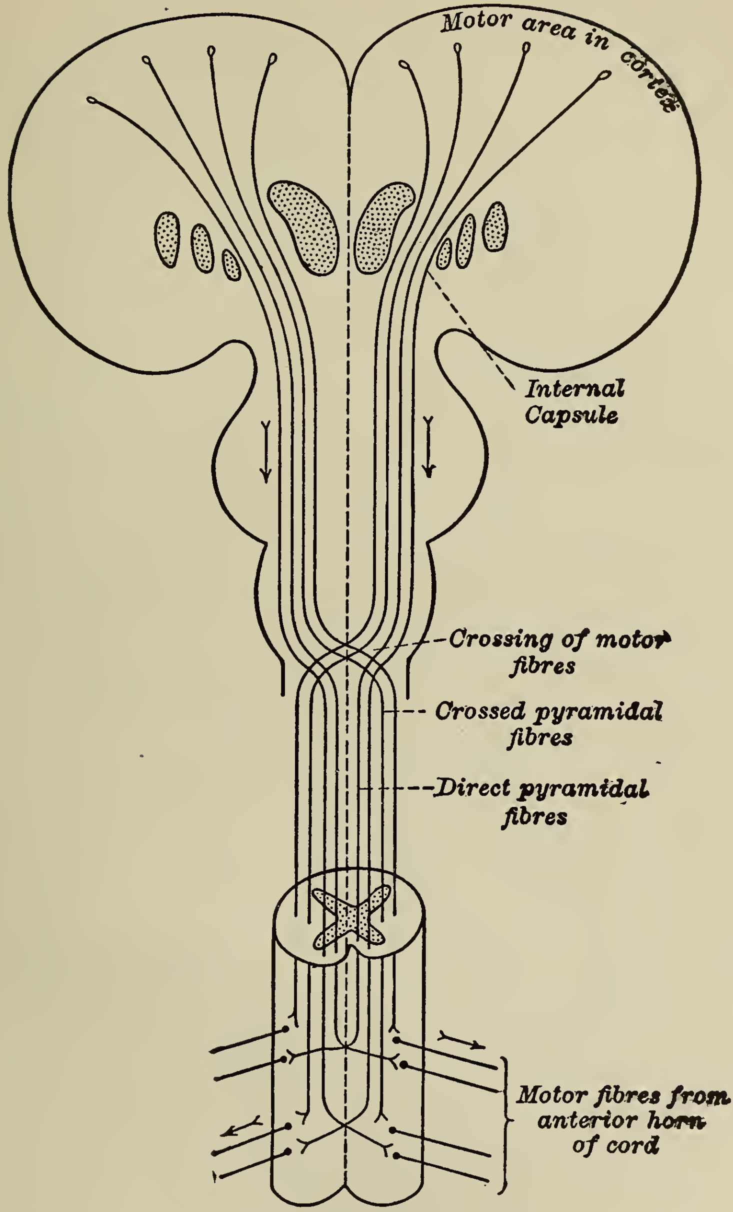



FIG. 21.—The motor tract.

neurones in the anterior horns of the spinal cord. They are known as the *pyramidal fibres*. From the cerebral cortex they pass down through the *internal capsule* to the pyramids

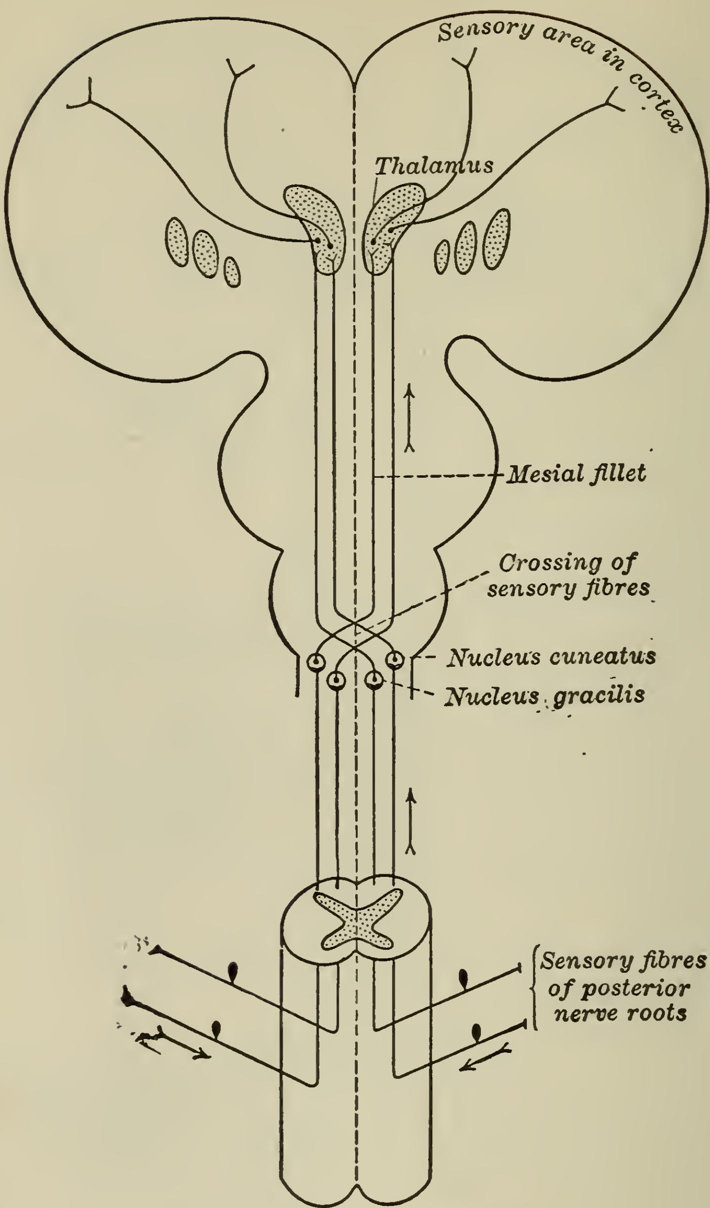



FIG. 22.—The sensory tract.

of the medulla. Here the larger part of the pyramidal fibres cross to the opposite side and descend in the lateral column of the cord as the *crossed pyramidal tract.* In each segment of the cord pyramidal fibres enter the gray matter of the cord and communicate with the motor neurones in the anterior horn, where originate the motor nerves which go to the muscles of the body. Some of the pyramidal fibres, forming the *direct pyramidal tract*, pass downward in the anterior column without crossing. These fibres, however, finally cross to the opposite side of the cord at lower levels, and in each case they communicate, as do the crossed pyramidal fibres, with the motor neurones in the anterior horn. Thus it is seen that each cerebral hemisphere controls the muscles on the opposite side of the body. Beside the fibres already described, other descending fibres run from the cerebrum to the cerebellum, which in turn sends fibres to the lateral and anterior columns of the cord.

The ascending projection fibres form the sensory tracts leading from the ganglia of the cerebral and spinal nerves. Nearly all the sensory fibres of the cerebral nerves go to the sensory nuclei in the medulla and pons. From these nuclei axons cross to the opposite side and communicate with the thalamus. From here other fibres send on the sensory impulses to the various parts of the cortex. In a similar manner the sensory fibres from the spinal nerves go from the spinal ganglia through the cord to nuclei in the medulla. From there new axons cross to the opposite side and pass through the mesial fillet to the thalamus and mid-brain, and thence to the cerebral cortex.[1] Thus impulses from the sense-organs from one side of the body are sent through a chain of neurones to the cortex of the opposite hemisphere. Beside the nerves which connect the sense-organs with the cerebrum there are other projection fibres which pass from the cord and medulla to the cerebellum, and from the cerebellum to the cerebral hemisphere.

[1] There are exceptions to this general rule. Many fibres from the sense-organs in the skin cross in the cord and pass upward in the opposite side of the cord. Some of the fibres from the sense-organs in the muscles pass upward in the same side of the cord and go to the cerebellum without crossing.

The fibres of the optic nerves follow a somewhat different course from that of the other cerebral nerves. The fibres from the inner or nasal half of each eye cross in the optic

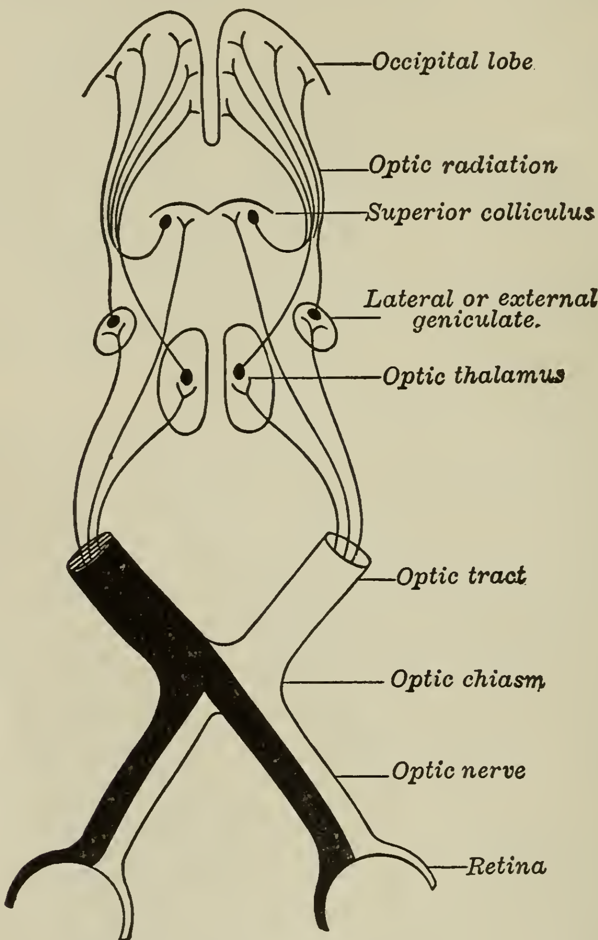



FIG. 23.—Scheme showing the distribution of the optic fibres. (From Howell's "Text-Book of Physiology.")

chiasma and go to the opposite side of the brain, while the fibres in the outer or temporal half of each eye go to the same side of the brain. These fibres from the retinæ end in the region of the thalami and upper quadrigeminal bodies. This region constitutes the lower visual centres. From here new fibres continue to the occipital lobes of the cortex and end there in the higher visual centres.

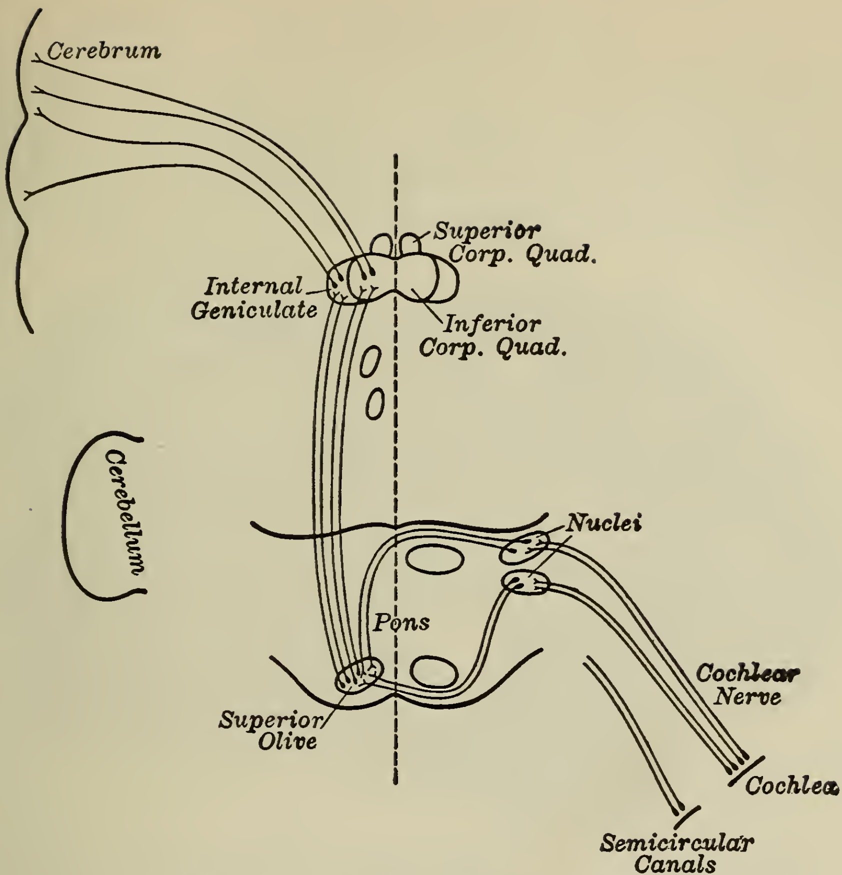



FIG. 24.—Scheme showing the distribution of the cochlear fibres.

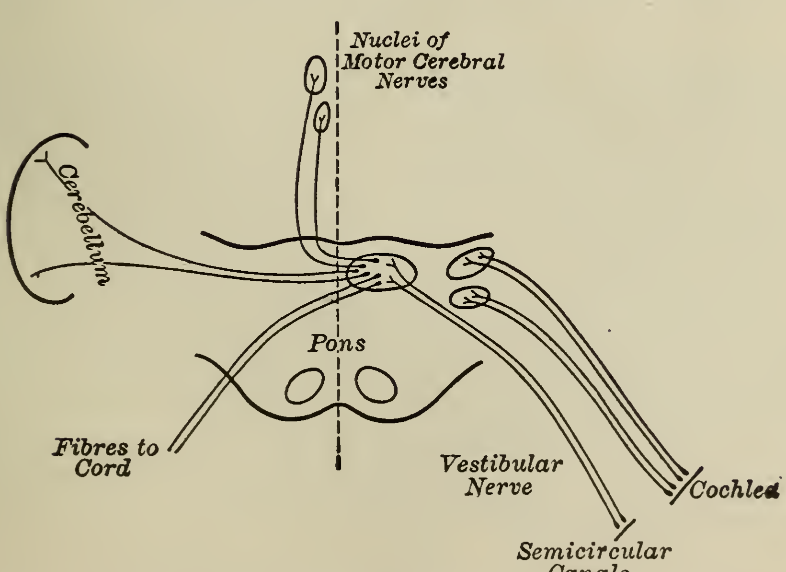



FIG. 25.—Scheme showing the distribution of the vestibular fibres.

The auditory nerve contains fibres from two different parts of the ear—the cochlea and the semicircular canals. The cochlear fibres go to the temporal lobes of the cerebrum, while the fibres from the semicircular canals go to the cerebellum.

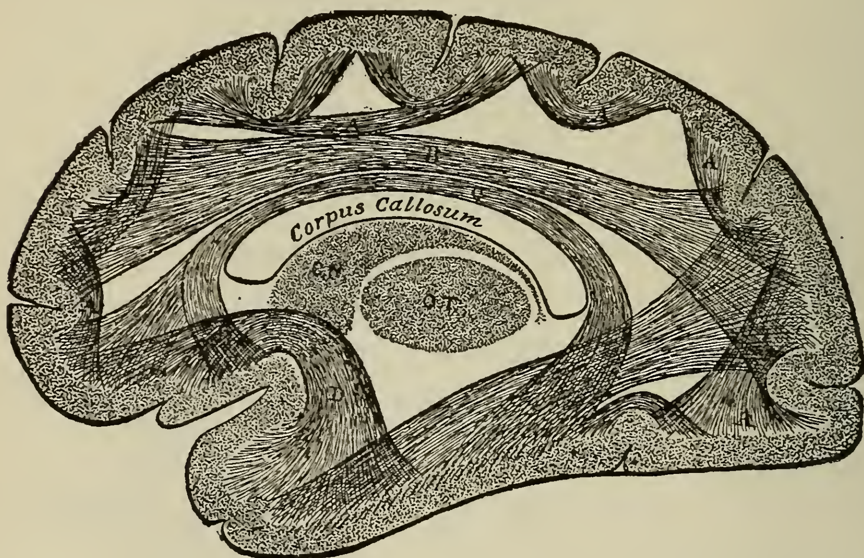



Fig. 26.—Cut showing the association fibres joining the different cortical centres with one another.

(From Ladd and Woodworth, after Starr.)

(2) The *association fibres* form the nerve pathways which connect the different parts of the same cerebral hemisphere[1] with each other. The sensory impulses which are projected from the sense-organs to the various sensory centres within the brain are reflected, or projected, back to the muscles from the motor centres, and find expression in movements. Now the connection between the different sensory centres and between the sensory centres and the motor centres are made by the association fibres. By means of short and long fibres both adjacent and remote areas of the cortex are connected with each other. The higher processes of consciousness—perception, imagination, memory, thought, etc.—demand the

[1] Or the cerebellar hemisphere.

co-operation of the various sensory areas and depend, therefore, upon the associative connections between them.

Complex forms of conscious behavior also depend upon the co-operation of different parts of the cortical areas.

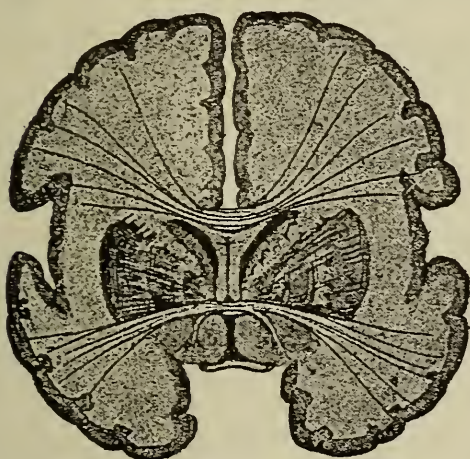


FIG. 27.—A transverse section through the two hemispheres showing commissural fibres connecting the hemispheres.
(From Judd's "Psychology," after Edinger.)

(3) The *commissural fibres* are found in all parts of the central nervous system. They are the fibres which connect one hemisphere of the brain and cord with the other. In the cerebrum the most prominent commissural pathways are formed by the corpus callosum and the anterior commissure. The fibres of the corpus callosum join the cortex of one side with that of the other. The fibres of the anterior commissure connect the temporal lobes of opposite sides.

**Localization of Function.**—With regard to function the subdivisions of the brain may be classed under two headings, the higher centres and the lower centres. The higher centres are located in the cortex of the cerebral hemispheres. These centres constitute the neural basis for the intellectual processes. The lower centres are found between the cerebral cortex and the cord and include the thalami, the corpora quadrigemina, the medulla oblongata, the pons, the cranial ganglia, and the cerebellum. The lower centres control, more or less independently of the higher conscious processes, the vital or vegetative processes of the body.

The *area of general sensations*—pressure, pain, and temperature sensations—occupies the convolution just posterior to the fissure of Rolando. The kinæsthetic sensations, or sensations of movement, also have their seat in this region.

The *auditory area* is located in the superior convolution of the temporal lobe.

The *visual area* is found in the cuneus and gyrus lingualis.

The *olfactory area* is situated in the forward part of the hippocampal convolution.

The *gustatory area* has not been definitely located, but is supposed to be situated in the hippocampal convolution just behind the olfactory area.

The areas which immediately surround, or lie adjacent to, the sensory areas proper, are supposed to be sensory psychic areas, or the areas involved in the understanding or comprehension of the sensations themselves. For instance, merely to hear a sound is one phase of the experience. To understand the sound as the sound of a bell, or of a passing street-car, is another phase of the experience. The psychic areas are responsible for this latter function. Injury to these areas may leave the individual able to hear, or see, or taste, etc., without being able to understand the nature of the sensations.

The *motor area* lies just in front of the fissure of Rolando in the precentral convolution and extends into the superior, middle, and inferior convolutions of the frontal lobe, and into the mesial surface of the hemisphere. The motor area may be divided into upper, middle, and lower regions. The muscles of the face, tongue, and larynx are controlled by the lower region; the muscles of the shoulders, arms, hands, and fingers are controlled by the middle region; the muscles of the trunk, legs, and feet are controlled by the upper region. In most cases the motor centres of one hemisphere control the muscles of the opposite side of the body. This is not, however, universally true. Certain muscles of the face, the muscles of mastication, and those of the pharynx and larynx receive motor fibres from both hemispheres. The fact that destruction of the motor centres in one hemisphere is not

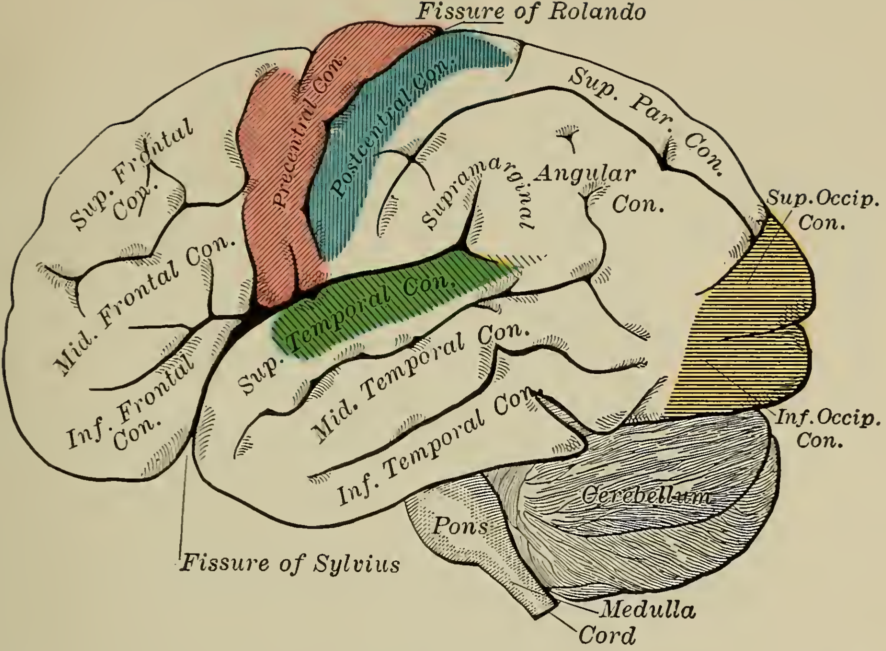



FIG. 28.—Areas of localization on the lateral surface of the hemisphere. Motor area in red; bodily sense area in blue; auditory area in green; visual area in yellow.

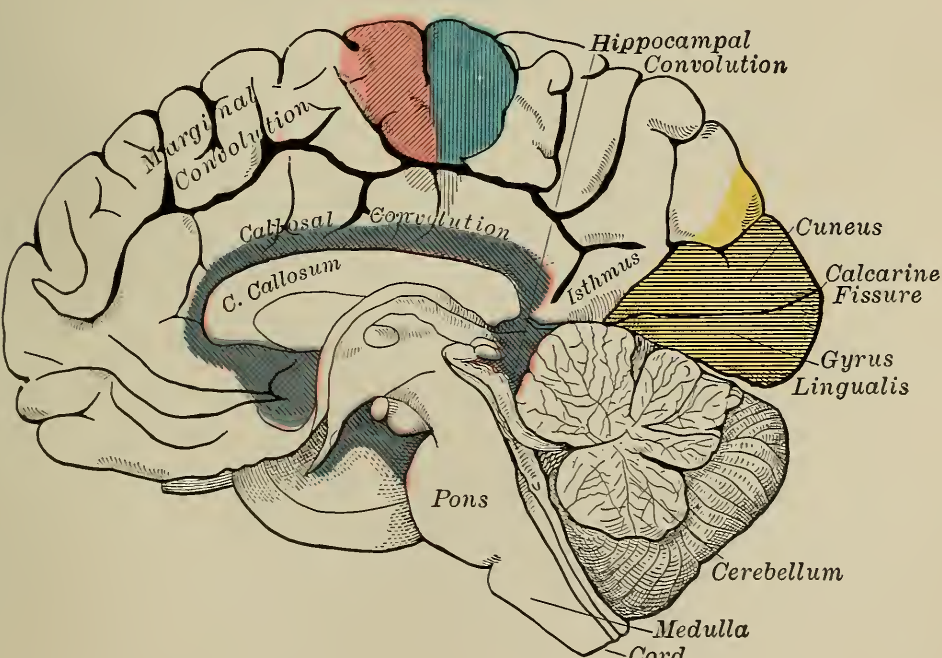



FIG. 29.—Areas of localization on the mesial surface of the hemisphere. Motor area in red; bodily sense area in blue; visual area in yellow; olfactory and gustatory areas in purple.

followed by complete paralysis of the muscles on the opposite side, indicates that these muscles are partially controlled by the motor centres of the other hemisphere.

The *association areas* occupy portions of the cerebral hemispheres not taken up by the sensory and motor areas. Three

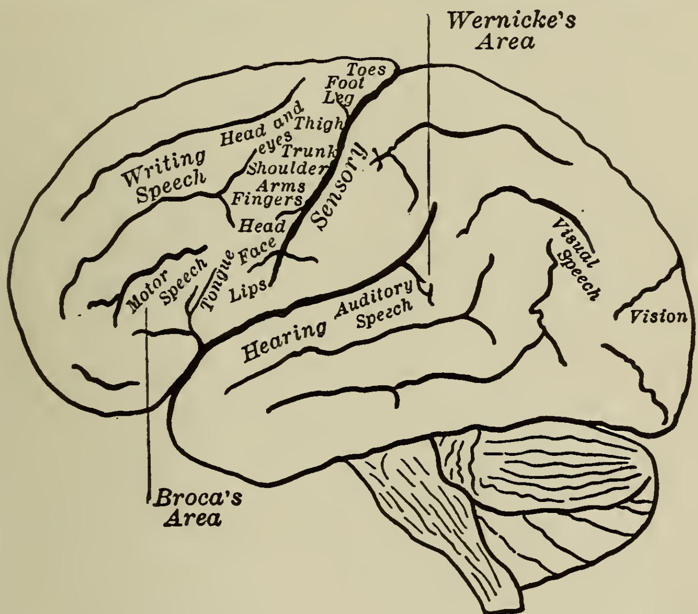



FIG. 30.—Diagram showing the chief regions of the motor and sensory centres.

large areas may be designated as association areas: the *anterior associational area* occupies the fore part of the frontal lobe; the *middle associational area* occupies the Island of Reil; the *posterior associational* area occupies a large part of the occipital and temporal lobes and practically all of the parietal lobe. These areas are supposed to be the centres for the higher conscious processes—the intellectual centres, so to speak. It is here that the various sensory experiences are co-ordinated and elaborated into processes of knowledge and thought. These centres are often referred to as the Flechsig areas from the fact that Flechsig first pointed out that the myelination or development of the medullary sheath of the nerve-fibres to these areas takes place only after the myelination of the nerve tracts to and from the sensory and motor centres has taken place. At birth, according to Flechsig, all the sensory fibres of the lower parts of the brain are developed, but only two tracts—the olfactory and the gustatory—are developed within the cerebrum. Gradually, however, the tactual, visual, and auditory tracts become myelinated and ready to function. The tracts from the various sensory centres to the association areas are the last to develop. Upon this fact, together with the supposed fact that the cellular structure within the association areas is uniform and different from that in the sensory and motor areas, he based his theory that the association centres are the higher intellectual centres. Later investigators have demonstrated that not only do the several sensory and motor centres show a different cellular structure, but the various parts of the association centres also show differentiation in this respect. If each specific form of cell-structure of the cortical areas corresponds to a particular mental function, the association areas will some day be mapped out to indicate the localization of the different intellectual functions. At present, however, we know very little about the function of these large association areas. There is sufficient evidence to establish the fact that certain parts of these areas lying adjacent to the sensory centres serve as memory areas for these centres. For instance, clinical cases have been reported in which loss of ability to recognize objects seen, or held in the hand, or heard, follows a lesion in the brain areas in the immediate vicinity of the visual, tactual, or auditory sense areas respectively. In such cases the patient can see and feel and hear the objects, but memory for the sensory experiences is lost. On the other hand, while destruction of the sense centres alone is followed by blindness, deafness, etc., memory for the sensations received before the injury is still intact.

The *motor speech centre* lies in the inferior frontal convolution in the left cerebral cortex. Injury to this centre (*Broca's Centre*) is followed by the loss of the ability to speak properly. This condition is known as *motor aphasia.* Broca's convolution is evidently not the centre for the muscles of speech; for in cases of motor aphasia the patient is still able to pronounce words. The words do not, however, form sentences or express meaning, but are hopelessly mixed.

The *sensory speech centre* also is found on the left side in the posterior part of the superior temporal convolution and in the adjoining part of the superior marginal convolution (*Wernicke's Centre*). Injury to this centre is followed by the loss of the ability to understand spoken words. The patient is still able to hear words, but he fails to comprehend them. This condition is known as word-deafness or *sensory aphasia.*

The *visual centre for written language* lies just posterior to Wernicke's Centre in the angular convolution. Injury to this centre is followed by the loss of the ability to recognize or understand printed or written characters. The patient is able to see the characters, but they mean nothing to him. This condition is known as word-blindness, or *alexia.*

The speech centres seem, therefore, to be psychic centres within which images of the movements of articulation, of the sound of words, and of the visual forms of written characters are aroused. When such mental representation is made impossible by brain lesions, aphasia, or the inability to use or understand words, results.

It has been claimed by some authorities that the language centres in left-handed persons are located on the right side of the brain, but this claim has been denied by other investigators.

The two halves of the brain are not identical in function. Not only is speech a one-sided function, but many consecutive and skilled movements of the hands and fingers are controlled by one side of the cerebral cortex, usually the left hemisphere. In many cases of lesions of the left hemisphere, followed by paralysis of the right hand, there is also a serious impairment of the ability of the left hand to execute movements. Cases have been reported in which lesions in the corpus callosum, the band of fibres which connects the two hemispheres, are followed by a lessening of the ability to use the left hand, a result due, without doubt, to the fact that the conscious factors involved are conditioned by the left cortex. It would seem, therefore, that the images necessary for the conscious control and execution of certain acquired movements depend very largely upon the activity of the left cerebral cortex.

The higher complex intellectual processes are probably not located in any single cortical area, but depend upon the co-ordinated activity of many, if not all, of the cerebral areas.

# CHAPTER III

## ATTENTION

If we examine our consciousness at any moment we find that a part of its content stands out in bold relief from the rest—that we are mentally occupied with some one presentation of the senses, or engaged in the elaboration of some thought or idea, at the expense of other possible presentations or ideas. In other words, we find that some part of the content is clearer and more definitely in consciousness than the rest of it. If our eyes rest upon a landscape, some one object momentarily occupies the centre of our awareness. If we listen to the sounds of the street, some one sound is clear and distinct, or at least clearer and more distinctly apprehended than the other sounds of which we are conscious. If we are absorbed in meditation, some one idea is uppermost in our thinking. We further observe that there is a constant shifting of the elements of the total content. Now one and now another part of the content becomes clear and definite, and then fades to give place to its successor. There is a constant change from clearness to obscureness and from obscureness to clearness. We also find that, at any one time, although there are a number of different objects appealing to the senses, or different ideas that might be entertained in the mind, yet it is always one of them, or a single group of them, that occupies the centre of the stage. Another fact we notice is that the changes in the content take place in a definite order, either in accord with some inner plan of action or thinking, or in conformity to the order of presentation of outer objects. We shall see in a later chapter that the rise and fall of ideas in the clearest part of consciousness takes place according to a general law—the law of association.

For instance, if at this moment I am thinking of Harvard University, the next clear thought that comes into my mind is that of Professor James. This is because of the past association of these two thoughts in my experience.

We also notice that these changes in the nature of consciousness are accompanied by impulses to movements in the various parts of the organism, especially in the muscles of accommodation of the sense-organs. The eyes are adjusted in seeing. The head is turned in hearing. Movements of inhalation are made in smelling. These movements serve to make the stimulus in each case more effective. Besides the movements of sense-accommodation, other movements of the body can be detected. Facial expressions and bodily attitudes conform to the changes of thought. The wrinkled brow and the constrained attitude are usually present in deep thought. The smile and the frown each correspond to definite qualities of consciousness. Changes in heart action and respiration parallel the changes in mental activity. So we can say that wherever consciousness changes its direction, there we may find impulses to movement.

As a result of movements of accommodation in the sense-organs and expressions in other parts of the body during the activity of consciousness, there arises a complex of sensations which become a part of the content of experience. This complex is made up of sensations of strain and effort in the various muscles. When we listen for a certain sound we distinctly feel the tension of the muscles of the neck and the faint sensations in the muscles of the middle ear. When we look for a certain object in a scene before us we feel quite as distinctly the movements of the eyes. When we try to remember or solve a difficult problem we feel the sensations of strain in the muscles of the forehead. All these sensations are designated by the term kinæsthetic sensations—sensations of movement.

Lastly we notice that the changes in consciousness are often co-ordinate with feeling. The ideas and thoughts that come clearly into our minds, and find lodgment there, are frequently those that appeal to us—those that refer to things we like or those that are useful in avoiding the things we dislike. We seek the pleasant and avoid the unpleasant. Consequently the ideas and sensations that become clear and definite are those that possess affective qualities.

Now, in our examination of consciousness we have noted the following characteristics:

1. Structure into clear and unclear parts.
2. Change of content.
3. Selection of certain parts of the total content.
4. Sensations of adjustment—kinæsthetic sensations.
5. Affective quality.

These are the characteristics of consciousness which make up *attention*. At one time or another in the history of psychology each of these characteristics has been picked out and put forward as the fundamental character of attention. This accounts for the various definitions and points of view which we meet in the literature of the subject.

If now, in addition to the content which we discover in the attention-consciousness, we assume or infer a subject of consciousness, or a permanent mind back of the content, we might be tempted, like some of the older psychologists, to define attention as the power of the mind to concentrate, change, and prolong conscious states. But by so doing we run into a *cul-de-sac*, for after defining attention as "the power of the mind," et cetera, we can go no further with the definition, because we know nothing about this mind, or ego, or self which exerts its power in this way. We cannot find out how it concentrates, changes, or prolongs conscious states. We gain nothing by this definition of attention beyond a convenient way of holding the facts together in our thinking. The danger of such a conception of attention lies in taking it as an explanation of the facts. However, it is a convenient way of speaking into which we often fall, even in empirical psychology. We speak of "the power of the mind to concentrate," "the activity of the mind in attending," or use other expressions which seem to infer that attention is some power back of the conscious states. If we understood what was said in the introductory chapter, it will be unnecessary when we use such expressions to stop and explain that we are not referring to a metaphysical entity by the words "mind" or "self," or that we look upon attention as something other than that found in the content of consciousness. It is true that in our popular thinking the clearness, the changes, the selection, and the motor impulses of conscious states are looked upon as due to the activity of some agent which we believe exists behind the contents of consciousness. But popular thought is saturated with uncritical metaphysics. Our business is first to consider the facts. All that introspection reveals to our observation in attention are the five characteristics which we have just enumerated. Of these characteristics of attention the most important one—the mark by which we define attention—is clearness. Clear or vivid consciousness is a universal characteristic of all attention, and unclear consciousness a characteristic of non-attentive consciousness. Several ways of describing the structure of consciousness in which attention appears have become current in psychology. The difference between attentive consciousness and non-attentive consciousness may be described as one of degree or level.[1] Attention is a high-level, while non-attentive consciousness is a low-level consciousness. The difference between the levels is, of course, that of degree in the clearness of consciousness. Whether there are only two degrees of clearness, or several degrees or levels, cannot be determined at the present time, although the experimental evidence favors the hypothesis of several degrees, which shade off from the highest degree of close or rapt attention to the lowest degree of diffused consciousness.

Another way of picturing the structure of consciousness is illustrated in Figure 31. Attention would then be the cen-

[1] Titchener: "Textbook of Psychology," p. 276.

tral circle, while the degrees of diffused or vague consciousness would be represented by a series of widening circles. The central circle is spoken of as the focus of consciousness, and the outer circles as the fringe, or margin, of consciousness.

Sometimes it is convenient to speak of attention as the foreground of consciousness, and non-attentive consciousness as the background. The foreground is clear and distinct, while the background is diffused or unclear.

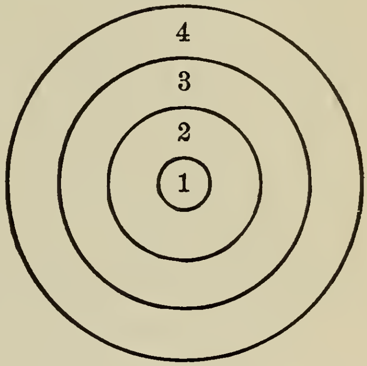


Fig. 31.—Graphic representation of the field of consciousness: 1, attention, or the focus of consciousness; 2 and 3, fringes of diffused consciousness; 4, subconsciousness.

All these pairs of terms—clear and unclear, high-level and low-level, focus and margin, foreground and background — describe the same fact, the difference in structure in the contents of consciousness at any one moment. The first term in each pair refers to the wide-awake and effective part of the conscious field, and suggests that attention is clear and central consciousness.

The fact that attention is constantly changing its direction, now resting upon this object, and now upon that, is another characteristic that we have noted. No conscious state remains clear or focal for any length of time. This has given ground for the definition of attention as the most active part of consciousness, and has introduced the idea of attention as a *process*, or an *activity*, a functional characteristic as distinguished from the structural one we have just been discussing. And then the further observable fact that attention gives itself to one of many objects presented to the senses, or to one of many possible lines of thought, adds another characteristic to the conception of attention and gives rise to the definition of attention as *selective consciousness*. If we emphasize the fact that attention involves certain adjustment activities which turn the sense-organs toward the object to be attended to, or that certain movements of the body are made anticipatory to ideas we entertain in attentive thinking, we have still another characteristic. It is in this case *rudimentary will*, or *conation*. And still again, if we pick out the sensations of strain and effort in these movements of accommodation we have another characteristic which we may look upon as the chief mark of attention. We may then define attention as a complex of kinæsthetic sensations which we sense as *effort*. If, in turn, we emphasized the fact that consciousness follows the lead of our feelings, we could then define attention in terms of the *affections* or *feelings* which control the direction of conscious activity.

Bringing all these characteristics together, we have attention defined variously as *clear*, *active*, *selective*, *volitional* or *conative*, *effortful*, and *affective* consciousness. But this is a list of the fundamental characteristics of consciousness itself. What we have been describing is a whole state of consciousness. Attention is just consciousness at its best—consciousness doing its work with its greatest efficiency and despatch. Attention is not a separate or independent function, but "the mind at work or beginning to work upon its object."[1] It is a common and constant function of all efficient consciousness. All processes and conditions of fully developed consciousness take place in attention. Sensation, perception, imagination, memory, judgment, conception, reason, emotion, and will occur most completely at the crest of the wave of attentive consciousness. Attention, then, is any state of consciousness that is fully and completely conscious, fully and effectively active.

**Forms of Attention.**—The existence of many phases or characteristics of attention makes possible a variety of classifications of the kinds of attention. Since all of these characteristics are not equally present in all cases of attention, their presence or absence forms a basis of classification.

[1] Attention—Baldwin's "Dictionary of Philosophy and Psychology."

Attention is sometimes set up and controlled by the intensity and character of outside stimuli, and sometimes by the activity of consciousness itself, *i. e.*, by conscious plans or purposes within the mind. Again some cases of attentive consciousness show a marked degree of effort and strain, while other cases contain very little or none at all. Sometimes attention is occupied by sensory stimulation and material objects, and sometimes it is absorbed in the intellectual processes of memory, judgment, and reason. The classification of the forms of attention varies accordingly as we emphasize one or the other of these facts.

One of the most popular classifications is that which divides attention into—

1. Non-voluntary attention.
2. Voluntary attention.
3. Involuntary attention.

*Non-voluntary attention* is the attention given to any mental content without being directed or controlled by conscious purpose or attended by effort of any kind. In popular language we say that it is attention *without* the will. Non-voluntary attention may occur in young children before conscious purpose is developed when the direction of their thoughts is determined by influences outside of themselves, and in adults when conscious purposes are in abeyance. In the case of the child, sounds, colors, lights, and moving objects will easily attract and hold his attention. As he grows older, familiar and interesting topics of thought will capture his attention without effort or purpose on his part. In the case of the adult, non-voluntary attention is found in flights of fancy, day-dreaming, and when we have become thoroughly absorbed in some interesting subject, or topic of thought, where effort or explicit purpose is not necessary to hold the attention. Non-voluntary attention has sometimes been called *spontaneous* attention. It is spontaneous only in the sense that it springs up without self-constraint, and represents the native and acquired tendencies that are firmly implanted within us. First our organic needs—food and shelter stimuli, and situations which call for actions of self-defense—attract and hold the attention. Later, the things that are in conformity with our acquired characteristics and touch the chords of our maturer nature appeal successfully to the attention.

*Voluntary attention* is the attention we give as a result of some conscious purpose or plan which we wish to carry out, and is always attended by feelings of effort and strain. It is attention *with* will. Plainly, voluntary attention is possible only where mental development has reached a certain degree of perfection, for it involves the presence in the mind of purposes and desires which are the result of past experiences, and which are represented in consciousness as a future mode of activity. Voluntary attention is evidently an outcome of non-voluntary attention. Conscious purpose and choice can arise in the mind only as an outcome of a conflict in non-voluntary attention. When two or more rival stimuli bid for the central position in consciousness, then voluntary attention becomes possible as self-initiated and self-directed consciousness. What enters the mind then is determined by premeditated choice. Voluntary attention may be transformed into non-voluntary or spontaneous attention. Where at first we attend with conscious effort and with difficulty, we in time come to attend spontaneously, and therefore without effort. Voluntary attention, then, has both its beginning and its end in spontaneous attention.

*Involuntary attention* is the attention we give to any object or topic of thought in spite of, or in direct opposition to our desire to attend to something else. It is attention *against* the will. The thing we attended to forces itself upon us even though we strive to keep it out of our consciousness. Intense stimulation of any kind, loud or sudden sounds, bright lights, abrupt changes, moving objects, bodily pain, insistent or fixed ideas, consuming sorrows and alluring pleasures, all force themselves into the centre of our consciousness, in spite of our effort to keep them from entering. This form of attention should not be confused with non-voluntary attention, for while involuntary and non-voluntary attention are alike in the fact that it is the force of the stimulus itself rather than any purpose in the mind that starts the attention process, involuntary attention is always complicated with effort against, or away from, the incoming stimulus or topic of thought which captures the attention. However, it is evident that the things that do succeed in taking the citadel of our consciousness by storm are the things that awaken our spontaneous or non-voluntary attention. From this point of view involuntary attention is the old non-voluntary attention come back to us.

Another classification of the forms of attention which has been even more popular than the preceding one is that which divides attention into—

1. Passive attention.
2. Active attention.

*Passive attention* corresponds very closely to non-voluntary or spontaneous attention. When an intense or sudden stimulation forcibly breaks into our consciousness, or when some insistent idea takes possession of us, we are, in respect to the initiation of the attention process, passive. We do not start the process; something outside the self commands it. The term passive, however, is a misnomer if it is used to describe the attention process itself, for all attention is active once it is set up. "Passive" refers only to the fact that attention may be determined by something which is outside of the self, not that the attention process itself is passive.

*Active attention*, on the other hand, is self-determined, *i. e.*, we take the initiative in starting and maintaining the process. It is really voluntary attention. When we attend because of some conscious purpose or plan in our mind *we* are active in initiating the attention process. Active attention is always the result of effort and is attended by strain-sensations, while passive attention requires no effort on our part and is free from strain-sensations, at least in its initial stage.

Passive attention may easily pass into active attention; *e. g.*, the forcible presentation of some object may start a voluntary train of thought or an active examination of the object in conformity to some plan which we wish to carry out.

Still another classification divides attention into—

1. Sensory attention.
2. Intellectual or ideational attention.

This classification does not consider the attention process itself so much as the kind of material upon which the attention works.

*Sensory attention* is the attention we give to the object which stimulates the sense-organs. Its direction is therefore determined by our environment. Sensory attention is also in many cases non-voluntary and passive attention, but it is not coextensive with these forms. For it is evident that in a given environment we, ourselves, may be active in determining the objects to which we give our attention, *i. e.*, the sensations to which we attend. In this case sensory attention is coexistent with voluntary and active attention. Those cases of passive attention where memories or ideas force the attention lie, of course, outside of sensory attention.

*Intellectual or ideational attention* is the attention we give in memory, imagination, judgment, reason; in short, in all the mental processes other than sensation and perception. Most of the cases of intellectual attention fall also under voluntary and active attention, although not all of them. For instance, in cases of attention set up by insistent or fixed ideas, attention is both intellectual and non-voluntary, or passive.

In much of our conscious life these distinctions between the forms of the attention are not present as absolute lines of demarcation. The forms of attention merge into each other or are present in one state of consciousness in varying degrees.

Oftentimes it is impossible to determine whether we are attending because of some purpose in our minds, or because of the intensity of the outer stimulus. Both influences may be at work. Again, a state of consciousness is rarely, if ever, purely sensory, for every stimulus awakens intellectual processes as well as sensory processes. What we are conscious of at any moment depends in varying degrees upon both our surroundings and upon the nature of our present and past experience. Sometimes the force of the environment predominates, and sometimes the purposes and plans within us are uppermost in consciousness.

From the genetic point of view these forms of attention represent stages in the growth and development of consciousness. Non-voluntary attention, passive attention, and sensory attention are, in large part, the first kind of attention to appear. How consciousness becomes clear and vivid in the beginning involves the problem of how we can be conscious of an outside world at all. At any rate, the fact remains that sense-stimuli acting upon a nervous organism force their way to consciousness, and this consciousness is the germ of attention. Whether or not they arouse clear and definite awareness at first, they certainly occupy the centre of what consciousness there is, and call out the native reactions of the organism. Bodily adjustments and sense-accommodations take place. Sensations of movement and simple feeling are awakened. The whole organism, mental and physical, is centred upon the stimulus. All the essential characteristics of attention are present. But it is a *native* or *reflex* attention, the attention which the organism gives because by virtue of its inherent nature it cannot do otherwise. The organism is so constituted that certain stimuli attract it spontaneously, *i. e.*, without effort or constraint on its part. In this stage of development it is the character of the stimuli which determines the selection of attention, *i. e.*, to what stimulus among the many which present themselves the organism will react. Stimuli of high intensities or of certain qualities, often-repeated stimuli, sudden changes, movement, the strange or novel, food and shelter stimuli, all these possess a native attraction and are, therefore, attended to. They have been significant signs in racial development and evolution, marking out the pathway of self-preservation for the individual organism. They were signs of dangers to be avoided or of advantages to be gained; so the tendency to react to them has become native and hereditary.

A higher stage of development shows the organism able to retain and reproduce past experience. The organization of this experience into a system of self-experience, any part of which can be recalled, forms a new basis of control. As it acquires experience the organism becomes less and less subject to the domination of outside stimuli. It is able to take matters into its own hands, or, we might say less figuratively, the acquisition of new experience is determined by the nature of the old experience explicitly reproduced and formulated into purpose, plan, or desire. Or, to put the same matter in another way, the old experience assimilates the new. What we attend to in this stage of development is determined by the experience we can reproduce from past states of attention. Effort and strain-sensations appear as a result of sensory and bodily adjustments we consciously make. Moreover, the effort appears as self-effort, because it follows or accompanies the conscious plan or purpose within the mind. We now attend because we will to attend. This is voluntary attention, active attention, or intellectual attention. It has grown directly out of the preceding stage of non-voluntary, passive, or sensory attention[1] in so far as

[1] It has already been noted that sensory and intellectual attention are not coextensive with non-voluntary and voluntary attention. Part of sensory attention may come under voluntary attention; *e. g.*, one may voluntarily attend to some sense-stimulus. Or intellectual attention may be non-voluntary after voluntary attention has been transformed into acquired non-voluntary attention; *e. g.*, the student may attend without effort to his exercises in logic after he has thoroughly mastered them. However, in the beginning non-voluntary attention is largely sensory attention.

these last forms of attention are evoked by the character and force of external stimuli.

A still higher degree of development appears when voluntary attention in any particular field loses its effort and self-constraint and becomes spontaneous. This represents the highest stage of mental development and efficiency. With respect to the attention it may be designated as *acquired spontaneous*. In time we come to attend spontaneously, and in quite as free and unconstrained a manner as in native spontaneous attention, to our studies and our work. Art, literature, and science may become second nature. They may appeal to us and challenge our attention unaided by any effort on our part.

In the order of development, then, consciousness first shows itself as *native* or *reflex attention*. Out of this develops *effortful* or *voluntary attention*, representing the stage of self-growth and self-development. Then comes *acquired spontaneous attention*, representing the stage of self-mastery and achievement.

If now we review all the forms of the attention we shall find that there is one characteristic that is universally present. We refer, of course, to the characteristic of clearness. However attention may be determined—by the external stimulus, by conscious purpose, or by sensory or intellectual activities—the attention itself is clear consciousness, *i. e.*, in attention we are more keenly conscious of some objects than of others, of some topics of thought than of others.

Clearness must not be confused with high intensity or opposed to low intensity of stimulation. A low degree of a sensation may be perfectly clear in consciousness, or a high degree may not be attended to at all, *i. e.*, it may not be clear.

For instance: the pop of a tiny firecracker may be perfectly clear in consciousness, while the boom of the cannon, although present in consciousness, may not be attended to and therefore may not be clear. The sound may have a high degree of intensity but a low degree of clearness. It is true that high intensity usually attracts attention and becomes clear, and that low degrees of intensity escape attention, but clearness and intensity are different attributes of consciousness. Whether attention increases the intensity of a sensation or not, *e. g.*, whether a continuous sound of constant objective intensity changes its intensity when we attend to it, is a question at present in dispute.[1] It is evident, however, that if there is any change in the intensity of presentation when it reaches the focus of attention, the change is so slight that it escapes ordinary observation.

It is a common belief in popular thought that the degree of attention is proportionate to the amount of effort expended in attending. The more effort we put forth the higher the degree of attention. This is true only within very narrow limits. In voluntary attention it requires effort to direct and hold the attention, and for a short time the degree of attention increases with the amount of effort. But in the higher degrees of attention, absorbed or rapt attention, there is no observable effort at all. If one becomes deeply attentive all effort to attend disappears. This is true in all cases of acquired spontaneous attention. A better measure of the degree of attention is the despatch and efficiency with which certain unfamiliar tasks are performed; *e. g.*, the time required to learn a certain number of nonsense-syllables or the accuracy and the time required to cross out the "a's" on a page of printed matter. Another measure is to note the strength of a distracting stimulus necessary to produce a decrease in efficiency with which one performs a task requiring close attention, and use that as a measure of the degree of attention.

Still another method is to take, as a measure of attention,[2]

[1] A minimal degree of intensity which lies just below the threshold of non-attentive consciousness may be raised above the threshold when the attention is turned upon it, *i. e.*, one can hear the ticking of a clock when attention is given to it, while without attention it is inaudible. This may not be due to an increase in intensity, however.

[2] Oehrn: "Experimentelle Studien zur Individualpsychologie," *Psych. Arbeiten,* I.

the variations which we make in a series of accurate measurements under the same conditions. Say, for instance, one is measuring the length of a screw to thousandths of an inch, and several series of ten measurements each are made. It is evident that the higher the degree of attention given to any series of measurements the less the variation in the individual measurements will be. The mean variation, or the average departure from the average measurement in any series would be an indication of the degree of attention given in the series. In some series the variation would be small, in others large, and since the variations must be in the mental factors, we can reasonably suppose that the most important factor—attention—is the variable element. Obviously none of these methods measures attention itself.

What is commonly spoken of as inattention is not inattention, but attention to some other topic than the one at hand. When we say that a schoolboy is inattentive to his lessons it is oftentimes true that he is deeply attentive to something else—the drawing of the teacher he is making or the bent pin that he intends placing on the seat of his enemy across the aisle. The enterprise in which he is engaged has completely displaced the lesson. There is, however, a positive state of attention which has inappropriately been called inattention. It is attention of a low order and exists in the general forms of *wandering attention* and *dispersed attention.* In wandering attention consciousness is abnormally unstable, flitting from one thing to another so rapidly that it is inefficient. In dispersed attention objects and ideas do not stand out clearly and distinctly. Mental states are not focalized sharply, and so consciousness is blurred and hazy. These forms of attention are frequently the signs of inanition, anæmia, a general lowered bodily condition, fatigue, or even of mental disease.

**Neural Basis of Attention.**—If now we ask what the brain conditions are that are concomitant with clear and vivid states of consciousness, we are forced to theorize, for the physiological facts concerning the neural activities in the brain areas during consciousness have not yet been made out. We may fairly assume, however, that definite states of consciousness involve definite activities in certain brain centres; that the neural excitement in these centres is for the moment raised above that in other centres; that changes in attention correspond to changing areas of excitement or tension in the brain. Now, we have seen that there are in general two factors which determine the direction of attention: (1) the nature of the external stimulus (bright lights, loud and sudden sounds, etc.), and (2) the nature of consciousness itself (effect of past experience, conscious plans and purposes, and ideas present in the mind). If some external stimulus, by virtue of its character, forces the attention, we can conceive the neural activity as working upward from a lower level or lower unit to a higher level or higher unit of nervous activity; *i. e.*, the stimulus first raises the activity in a particular sense centre above that in the other parts of the brain, and then drains off into, or involves the activity of, a higher neural unit or level which has previously been associated with the activity of the sense centre. The particular way we may attend to the given stimulus, the way we perceive it, is determined by the way we have perceived it in the past, and by the nature of consciousness at the time; *e. g.*, the way in which I attend to the ringing of a bell outside—whether I perceive it as a street-car bell or as that of a baker's wagon depends upon my past experiences and my present surroundings.

This means that at any moment certain brain centres are more susceptible than others. Some authorities hold that this greater susceptibility of some centres over others is due to facilitation, others think that it is due to inhibition of rival centres, and still others are of the opinion that both processes are at work. Facilitation means that the action in one brain centre (in the case cited probably a higher centre) increases the action in another centre. Inhibition means that the action in the centres not involved in the attention-consciousness is lessened or blocked by the action of a higher centre. Thus if I attend to the bell as that of a street-car, the centre involved in "street-car perception" is facilitated, and the centre corresponding to "baker's wagon" is inhibited.

In the case where attention is determined by conscious purpose or plan, where we select one from several presented stimuli, we may conceive of the neural activity as working downward from higher units, and facilitating the action in the centres involved in the particular attention-consciousness, or as inhibiting the action of all other centres. Thus if I determine to listen to the faint strains of a distant street-organ rather than the nearer and louder noises of the street, certain centres are facilitated and all others are inhibited or blocked for the moment.

Whether there are definite brain centres whose function it is to control these processes of facilitation and inhibition in attention, or whether any part of the higher brain may so act, is not known. It has been suggested that the so-called associational areas in the frontal lobes of the cortex are alone responsible for the facilitations and inhibitions in the play of attention-consciousness. Pathology has determined the fact that lesions in this part of the brain involve impairment of the attention especially. Comparative neurology shows that the size of these frontal areas goes hand in hand with the development of attention. We also know that in very young children, before sustained attention is possible, the frontal areas are not yet matured—that the nerve-fibres in this area have not acquired their myelin sheath, and are not, therefore, ready to function.

However, in view of the paucity of detailed facts in the anatomy and physiology of the nervous system, we must suspend judgment concerning the neural basis of attention. It is all very vague and indefinite as yet. We can only hope that the rapid development in these sciences will throw more light upon the question.

**Shifting of Attention.**—We have already noted the changing aspect of consciousness in attention. No mental content remains clear long—it rises and falls intermittently. This changing of attention is observable in topics of thought involving the higher mental processes, memory, imagination, judgment, et cetera; in the perception of objects, and in minimal sensations coming from stimuli of very low degree of intensity, *i. e.*, sensations which lie just on the lower threshold of consciousness. If we try to fix some one topic of thought, we find it impossible to hold any one aspect of it clearly in consciousness for any length of time. Thinking of one thing means that one after another of its aspects becomes clear in rapid succession. The content of focal consciousness is always changing. The same fluctuations occur when we attend to objects. This is illustrated in the perception of ambiguous figures. If we look at Figure 32, we perceive it as a cardboard bent toward us, changing the next instant into a cardboard bent away from us. These two aspects of the figure alternate in consciousness.

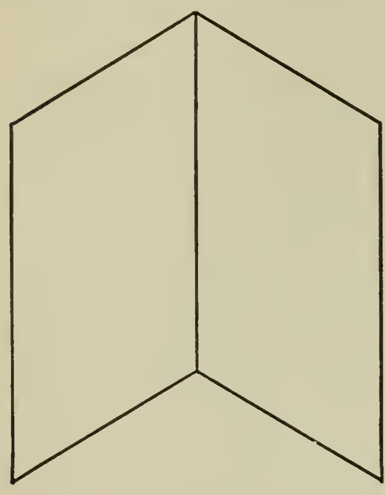


Fig. 32.

Observe the changing perceptions of Figure 33: It may appear as four lines of horizontal dots; or four lines of perpendicular dots; or as diagonal lines of dots; or as four squares; or as two squares, a smaller one included in a larger one; or in various other arrangements.

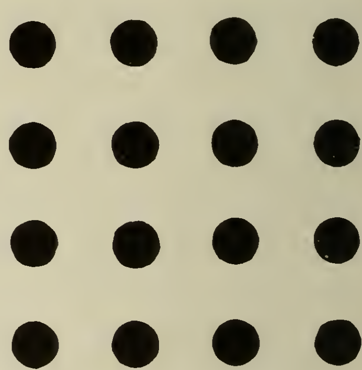


Fig. 33.

A special case of the fluctuation of perceptions is seen in binocular rivalry. Hold the open hand up before the right eye, select some object in the room that is screened entirely from the right eye but is in plain view of the left eye. Fix the attention on the object and it will apparently be seen through the hand. Part of the time it will stand out clear and distinct, part of the time it will be indistinct or even disappear completely, displaced by the perception of the

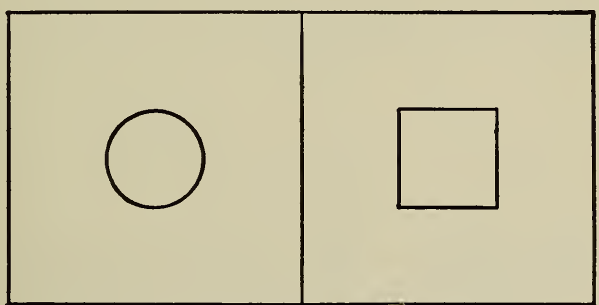


Fig. 34.

hand that lies between you and the object. The explanation is in the fact that part of the time you see more clearly with one eye and part of the time with the other. If a stereoscopic card is prepared with one-half-inch colored squares, red for the right eye and green for the left eye, and is then placed in the stereoscope, the red square is exposed only to the right eye and the green square only to the left eye. Under these conditions both squares seem to occupy the same position in the visual field, but only one of them is present in consciousness at a time. They alternate in a continuous rivalry, first one and then the other taking possession of consciousness. The periods of fluctuation vary slightly in duration with different subjects, but they average about two seconds in length. Now we find that the length of time that one of these colored fields remains clearly in consciousness is influenced by the same factors that accompany attention. If one field is more intense than the other it remains in consciousness longer.

Likewise, if one field has more complexity (lines and figures drawn upon it), or if eye movements or adjustments are made in conformity to the lines, or if one field is more striking in novelty, or is more pleasing, it remains in consciousness longer than the other.[1]

Hold an ordinary envelope between the eyes close to the face so that the circle (Figure 34) is cut off from the right eye. Fixate the square and the circle will disappear and reappear.

The same phenomenon can be observed where one object is in the margin of the visual field, and another in the central portion.

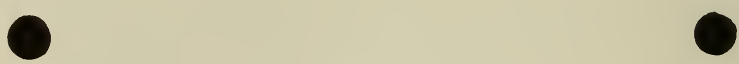


FIG. 35.

Fixate the right dot, which should be placed directly in front of the right eye and about four inches away; look at it steadily for some time. The left dot will disappear and reappear.

When the attention is turned to continuous minimal stimuli the sensations resulting from them appear intermittently in consciousness. Periods of clearness and periods of obscureness or total disappearance can be observed. If, for example, the attention is fixed upon a very faint gray line just discernible upon a white background, it will remain in clear consciousness only a short time, disappearing and reappearing. Masson's disc is a simple illustration of this.

A still simpler way to get the fluctuation is to fixate some spot on the wall that is barely visible. Faint auditory stimuli (the faint ticking of a watch or the sound of a stream of fine sand falling on a blotting-pad) are also intermittently clear and unclear. In the case of faint pressure, gustatory, and olfactory sensations, fluctuation is not as evident. Taste and smell sensations do change in clearness, but since it is impossible to get a constant stimulus in these cases the

[1] Breese: "On Inhibition," in *Psych. Rev.*, Mon. Sup. III.

changes might be due to changes in the stimulus. Inhalation and exhalation are constantly changing the intensity of the stimulus in the one, and the varying chemical changes of food in the other. Pressure-sensations sometimes show a less observable fluctuation, and here the varying blood-pressure may change the effect of the stimulus, too. In fact, it has been claimed by some that all these fluctuations in perceptions and minimal sensations are not due to the attention at all, but to the accommodation of the sense-organs, and no doubt this has much to do with it. The lens of the eye changes its curvature periodically, thereby changing the sharpness of the retinal image. The muscles of the ear contract and relax, varying the tension of the drum. Moreover, the periods of oscillation in consciousness have been observed to correspond to these changes in accommodation in the sense-organs.

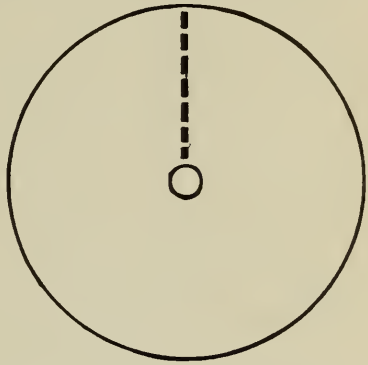


Fig. 36.—Masson's disc. When a disc of this kind is rotated, the short black lines give a series of faint, gray rings which grow fainter toward the circumference. The outer rings are barely visible. Fixate one of the faintest rings and it will disappear and reappear periodically.

So the question whether the shifts in consciousness are due to changes of accommodation in the peripheral sense-organs or to "fluctuation of the attention" is pertinent. Against the periphery theory has been offered the fact that fluctuations in visual sensations have been observed in cases where the muscles of the lens and pupil have been temporarily paralyzed by atropin; also where the lens has been removed by operation. In cases where the drum of the ear has been destroyed, fluctuation occurs in auditory sensations. But this is not conclusive. The absence of the lens of the eye does not preclude the possibility of fluctuation of sensitiveness to light-stimuli in the retina, the real sense-organ of vision. There is reason to believe that the delicate nerve-endings in the retina undergo rapid chemical changes, and that these changes affect their sensitiveness. This might well account for the fluctuation of minimal light-sensations. Likewise, there may be other sense-organ adjustments in the ear than those of the drum, and they may account for the fluctuations of minimal auditory sensation. It is therefore doubtful whether these fluctuations are due to changes in attention or to end-organ adjustments. In some cases we are reasonably sure that they are due to the latter.

For instance, in the case of the alternating red and green squares in the stereoscope, if, when I give my attention to the red square, the green square displaces it in sensory consciousness, I may still be thinking about the red square, attending to its quality, size, et cetera, so that the change in consciousness is not a change of attention. What really happens in this case is that part of the time I am attending to the sensory perception of the red square, and part of the time to its memory image. On the other hand, the green square may not occupy clear or attention-consciousness at all. When the green square is in consciousness the mental image of the red square is still clear, while the sensory experience of the green square is marginal. In the case of the disappearing faint gray ring of Masson's disc, I may still continue to attend to it after the gray ring itself has disappeared, by holding it in mind as a mental image. In other cases of minimal sensations where the sense-organ is not supplied with delicate movements of accommodation, as, for instance, in very light pressure-sensations, attention is able to maintain itself without change for very much longer periods.

Physiologically there are two factors to consider in these changes of consciousness: (1) the sense-organ activity and movements of accommodation, and (2) the central or cortical activity in the brain. Changes in attention are due to changes in the central brain activity—fatigue in the cortical cells, changes in blood-supply, anabolic and catabolic processes, et cetera. Now, while the central activities in the brain are sometimes the result of the nervous impulses from sense-organs, they may at other times be independent of them. The central neural activities corresponding to attention must be conceived as including larger brain areas than the areas involved only in the reception of sense-stimulation and, when once set into action, as continuing, even though the sense-organs are inactive. For instance, if I attend to a certain book on my desk, my attention may involve more than the brain activity in the visual centres. Past associations and consciousness of the relationship to other objects may be present. If the book is removed from my sight I may go on attending to it. Or if an inkstand is put in its place I may still attend to the book and at the same time be conscious of the inkstand. But in this case the inkstand is not in the focus of attention. So we infer that the brain activities corresponding to attention-consciousness involve larger areas than those corresponding to mere sensation or perception. We conclude, therefore, that attention may change with the changes of sense-stimuli or may act independently of them. Shifting of the attention involves more factors than those involved in the fluctuation of minimal sensations or in the rivalry of objects presented to the sense-organs. While attention cannot hold itself indefinitely to one thing, it is not limited so far as its maximum duration is concerned to the very short periods which characterize the fluctuation of minimal sensations, *i. e.*, four to eight seconds.

If we keep in mind the fact that the real function of consciousness, in all stages of development, has been to aid the organism in its adaptive adjustments to its environment, we can see why it is the nature of attention to shift. In order to survive, the organism has been forced to react quickly to a rapidly changing environment. One object after another has presented itself, and to each one in turn bodily adjustments had to be made. Presentation of an object, recognition of it, adaptive reaction, presentation of another object, recognition of it, another reaction, and so on in an ever-changing series of presentations and reactions, with consciousness mediating between them—such has been the history of development. Now, each recognition and adaptive reaction has required only a short space of time. Conscious life has developed under the constant pressure of a changing environment, and so it has come about that ordinarily a simple flash of consciousness is all that is required to take in any given situation and meet it by making the proper reactions.[1]

**Range or Span of Attention.**—How many things can we attend to at once? Common sense says that we can attend only to *one* thing at a time. Careful experiment, however, has proved this to be untrue. Yet it is true that in every-day experience attention is occupied only by a single object or topic of thought, but this does not represent the ability of attention in this respect, especially in the perception of objects. It has been found that when simple objects are presented simultaneously to the eyes, from four to six single objects can be apprehended at once. If simple sounds are presented successively, as in the taps of a metronome beating four times a second, six to eight taps can be perceived as a unit without counting the single taps. In the case of the simultaneous presentation of simple objects the length of time in which the objects are exposed to the eyes must be very short —short enough to prevent more than one act of the attention. The time exposure should be just long enough for the subject to perceive clearly a single one of the objects. This time period varies from 0.010 to 0.200 seconds. It is necessary, therefore, to use an accurate time-exposure apparatus, called the tachistoscope, for these experiments, although rough experiments may be carried on by means of an ordinary drop-screen.

The result of experimentation has also shown that attention can take in complex objects quite as easily as simple

[1] See Angell: "Psychology," 4th ed., p. 94.

objects. For instance, it was found that as many words as single letters can be apprehended in one pulse of the attention, *i. e.*, three to six words. Likewise, familiar groups of lines, dots, or objects may be attended to as a single impression or unit; and as many single groups can be perceived in one grasp of the attention as single objects. This means that when we attend to the single group the attention is not occupied with the single objects which make up that group. When we attend to a word as such, we do not attend to the single letters making up the word, but on the other hand we treat the word as the unit of attention. We may even treat phrases or sentences as units of attention. The same holds true in the apprehension of successive sounds. In one pulse of the attention some subjects can perceive four groups of four taps of the metronome, *i. e.*, sixteen single taps. In this case the attention is not occupied with the single taps, but with the groups. This illustrates the fact that an object may be attended to in different ways. Thus sixteen regular successive taps of the metronome may be perceived or attended to as sixteen distinct and separate sounds, with full attention given to each sound; at another time as four groups of sounds, and at another time as a single group of four groups. In the first case there are sixteen, in the second four, and in the third one act of the attention.

This grouping of objects is possible because we build up higher and higher units of perception, as a result of education and training. Starting first with the discrete sensory units, we soon learn to associate them into groups which we apprehend as single units. At first the schoolboy may attend to each single letter, but when the letters become associated attention moves on to the word. The letters in the word are present in consciousness, but they are marginal, *i. e.*, they are not in the clearest part of consciousness, for attention is occupied with the word or higher unit. Further training makes still higher units possible. The words may be grouped into phrases and sentences which are apprehended singly.

**Effect of Attention.**—In a general way we may say that attention increases the efficiency of consciousness. When the attention is turned expectantly in a certain direction everything is in readiness to receive the stimulus, the end-organs are accommodated, and the central brain centres are prepared in advance by virtue of the mental image of the expected stimulus. This increases the rate of entrance of the stimulus, and lowers the sensation threshold, *i. e.*, increases the sensitiveness of the nervous organism. The following simple experiment will illustrate the latter point. If cardboards upon which geometrical figures (squares, circles, or triangles) are drawn are presented to a subject at a distance at which the figures cannot be recognized, it will be found that, if the cardboards are brought slowly nearer to the subject, a distance can be determined where the figures will be just clearly recognized. Now this distance will be greater when the subject is told beforehand what figure is upon the card than it will be when he is not told what figure is upon the card.

The following table gives the results of five tests under each condition: First condition, the subject did not know what figure was approaching; second condition, the subject knew what figure was approaching.

| | First Condition | Second Condition |
|---|---|---|
| 1. Figure recognized at | 15.7 feet | 19.9 feet |
| 2. " " " | 16.0 " | 20.7 " |
| 3. " " " | 18.8 " | 16.8 " |
| 4. " " " | 15.8 " | 23.8 " |
| 5. " " " | 18.0 " | 16.3 " |
| Average distance recognized | 16.8 feet | 19.5 feet |

Here, when attention was given to the approaching stimulus, the distance at which it could be recognized was increased 2.7 feet. Likewise the threshold of auditory sensations is lowered by active attention. The same subject whose records are given above could hear the ticking of the laboratory watch (one he had never heard before) only when it was brought within a distance of ten feet from his ear. But when he had once heard it distinctly and attended to its peculiar sound he could hear it thirteen feet away.

The latent period of perception, *i. e.*, the time between the presentation of the stimulus to the sense-organ and the recognition of it in consciousness, is shorter in attention than it is in marginal consciousness. Every stimulus requires some time to develop in consciousness. It is, of course, a relatively short period, and is measured in thousandths of a second. This developing period goes on most rapidly in the focus of attention. Of two simultaneously given stimuli the one that is voluntarily attended to arrives in consciousness first. If we should attend closely to the revolving pointer of a complication clock,[1] and attempt to locate the exact position of the pointer when the bell strikes, we should find that the resulting sound, not being in the focus of attention, will require a longer time to develop in consciousness than the visual appearance of the pointer on the dial. Consequently the sound will be retarded in reaching clear consciousness. If, when the attention is on the pointer, the bell is arranged to sound when the pointer is at a given position on the dial, the sound will not reach consciousness until the pointer appears to the observer to be some degrees beyond. With the attention fixed upon the visual stimulus, the auditory sensation lags behind in consciousness. The visual sensations ripen more rapidly than the auditory sensations under these conditions, so that when the more slowly developing sound-sensation reaches consciousness, the visual perception of the pointer several degrees ahead on the dial has developed into clear consciousness. The sound and the pointer appear

[1] The complication clock is a graduated dial around which a pointer revolves from six to ten times per minute. The clock is connected, usually electrically, with a bell which may be made to strike a single note at any given position of the pointer.

simultaneous at the advanced position of the pointer, *i. e.*, there is a negative time displacement of the sound. If, now, attention is fixed upon the sound, the pointer, being in the margin of consciousness, will lag behind and will appear to be several degrees back of the given position when the bell sounds, *i. e.*, there is a positive time displacement of the sound.

Very common illustrations of this retardation of stimuli which are not attended to, but which have been received in marginal consciousness, are found in every-day life. If one is intently absorbed in reading or in deep meditation, it may happen that he does not notice the striking clock until the third or fourth stroke, and then become fully conscious that he has heard it striking from the beginning. The small boy who is busily engaged in play probably tells the truth when he says to his mother, after she has called him: "Mother, I didn't hear you until you had called the second time."

Attention increases the speed of movement. If, when a visual or auditory signal is given, a subject attempts as quickly as possible to make a simple movement, such as pressing down a telegraph-key, the reaction can be made more quickly if attention is focussed upon the movement to be made. Obviously, attention may be given either to the signal or to the movement. If attention is given to the signal, the time of reaction is termed "sensory-reaction time"; if, on the other hand, attention is given to the movement, it is "motor-reaction time." In most cases the "motor-reaction time" is shorter than the "sensory-reaction time" by from 0.080 to 0.100 seconds. The former is about 0.140, while the latter is about 0.240 seconds. However, when the movement becomes perfectly familiar or habitual, the difference between these forms of reaction tends to disappear. In general, we may say that the time of any conscious reaction is lessened when attention is given to the least familiar or habitual elements in it.

Since attention is the condition of all clear and vivid impressions, its effect upon memory is obvious. That which is attended to closely is more likely to be retained and recalled afterward than that which is not attended to. Furthermore, the order of recall is determined by attention. For what is remembered depends upon what is in the focus of attention at the moment. This not only determines the direction which the memory takes, but it also determines the sequence of thoughts in imagination, judgment, and reason—in short, in all consecutive thinking.

**Motor Accompaniments of Attention.**—We have had occasion several times to refer to the fact that attention is accompanied by certain bodily reactions. In fact, the connection between the motor activities of the body and attention is so intimate and constant that some psychologists hold that attention is fundamentally a motor phenomenon.[1] The attention we give in looking at an object, according to this view, is really and essentially nothing more than the turning of the body toward it, the accommodation and converging of the eyes upon it, the changed respiratory movements and heart action which take place when we attend to it. Or, more properly, the effect of these motor activities in consciousness is the only differentia between attentive consciousness and non-attentive consciousness. This theory would take the accompaniments of attentive consciousness as its cause. Although we cannot accept the theory that attention is essentially the effect of a set of motor accommodations, we must nevertheless recognize their importance in attention. For no state of attention exists that does not show definite motor adjustments peculiar to it. No one can give attention without manifesting signs of bodily reactions toward the object of attention. The accommodation of the sense-organ, the tension of the facial muscles, the strained motor attitude of the body, the slowed respiration and heart action are all marks of attention. It is doubtful if attention and a general relaxation of the muscles can take place at the

[1] Ribot: "Psychologie de l'attention."

same time. These motor reactions have their part to play in making the content of consciousness clear and definite.

Both the voluntary and the involuntary reactions are involved in attention. For instance, if we attend to a visual object, the turning of the head and eyes toward the object and the partial suspension of respiration may be voluntary, but the adjustments of the lens and the pupil of the eye and the capillary change in the blood-vessels are involuntary, or reflex. The motor reactions in attention, therefore, represent the whole organism, involving both the native and the acquired reactions.

Involuntary movements of the body are often sufficiently observable to the degree that they may be taken as indications both of the direction and nature of attentive consciousness. Many so-called mind-readers (really muscle-readers) take advantage of the involuntary movements of their subjects in detecting the nature and direction of attention. Especially is this true in cases where the "mind-reader" is attempting to find a hidden article, the location of which is known and kept steadily in mind by the subject. By watching the subject closely or by holding his hand as he leads him about the room, the "mind-reader" can detect involuntary movements of hesitation and negation, of acceptance and consent, which give clews to the position of the object. We may note these motor impulses in ourselves. If we think of an object directly overhead, slight involuntary movements of the head or eyes toward the object are observable. If we think of the word *bub-ble*, movements of the lips can be detected. If we think of biting into the pulp of a raw lemon, we are seized with involuntary shudders. Such movements are usually not noticed until attention is called to them.

Now, if we canvass all the movements that characterize attention we shall find that they fall into four classes:[1]

[1] See Pillsbury: "Attention," chap. II.

*First:* Movements of accommodation of the sense-organs, the purpose of which is to give a clearer impression of stimuli.[1]

*Second:* Movements of the voluntary muscles, expressly made for the purpose of taking advantage of the objects or ideas attended to in a way that has previously been found useful to the organism.

*Third:* Overflow movements in the voluntary muscles.[2]

*Fourth:* Reactions of the respiratory and circulatory muscles. The pulse and respiration curves show marked changes with the changing states of attention. The blood-pressure in the capillaries also varies with the attention changes.

These motor accompaniments are present not only in sensory attention (attention to objects presented to the senses), but, as we have already seen, they are also found in intellectual or ideational attention, attention given to memories, images, and ideas. The memory image of a green persimmon will cause the same puckering of the mouth, although perhaps in a lessened degree, which the fruit itself caused when actually experienced. To form the mental image of an object behind us involves the tendency to turn the head. The idea of coldness is accompanied with incipient shivers. In short, all our clear and vivid thoughts are accompanied by motor reactions that are more or less appropriate to them. Put in a way which will cover the facts of both sensory and ideational attention, we may say that all clear consciousness involves motor activity.

**Feeling of Effort in Attention.**—The fact that we experience effort and strain in voluntary attention leads naturally

[1] This should include the movements of the body which place the sense-organs in a more advantageous position with respect to the stimulus. These movements may be voluntary and so differ from the involuntary accommodations of the sense-organs, but their purpose is the same, *i. e.*, to give a clearer impression of the stimulus.

[2] It has been suggested that these overflow movements serve to keep the neural activity going in the same channel and thus inhibit the effect of disturbing stimuli. See Angell: "Psychology," 4th ed., p. 101.

to the assumption of an activity back of the contents of the attention-consciousness—a something that decides what things are to be attended to. Effort and strain are assumed to be the effort and strain of the attention itself. Now, careful observation reveals the fact that the effort and strain come from the motor accompaniments of attention, and not from attention itself. The contracted brow, the set teeth, and other bodily muscular tensions, together with the adjustments of the sense-organs, give a diffused mass of strain-sensations. They might very readily be taken in superficial observation for the activity of the attention.

**Interest and Attention.**—Popular thought has some very decided views concerning the relation of interest to attention. For instance, it is supposed that interest precedes and leads to attention—that we attend because we are interested, not that we are interested because we attend. While this view contains an element of truth, it involves a confusion of thought that may be easily corrected if we consider what interest really includes psychologically.

In the first place, interest, as we commonly use the term, includes attention. We cannot be interested without attending. Interest, therefore, cannot exist and then attract attention to it afterward, for the very reason that any state of consciousness that may be called interest has attention already in it. Interest is a complex mental state comprised of a clear and vivid state of awareness (attention), accompanied by feeling and conation (impulses to activity). When we are interested we are clearly aware of the object of interest, take a feeling attitude toward it, and are impelled to react in some way, *i. e.*, approach or withdraw from the object.

Interest { Vivid awareness (attention).
Feeling.
Conation.

The most important element in this complex is attention.

There can be no real separation of interest and attention. In fact, interest is only another name for non-voluntary or spontaneous (both native and acquired) attention. The things that we are interested in are the things that attract the spontaneous attention. Moreover, the order of the development of our interests is the order of development of attention. First come our native interests—food, shelter, intense stimulation, bright lights, loud sounds, moving things, etc., and last of all, our acquired interests—art, literature, science, our professions, occupations, etc. Between the native and acquired interests lies the stage of voluntary attention. Our acquired interests rest mainly in those things with which we have become familiar through voluntary attention.

Sometimes interest is used to signify only the affective elements in attention—the feeling of pleasure and satisfaction experienced with our states of awareness. We get pleasure and satisfaction out of the things that help us forward, and therefore we attend to these things. It is better to say that we get pleasure and satisfaction because we attend, for the pleasure and satisfaction are never experienced until after attention is given. If we go in quest of these interesting things, we must first attend to the memory images of them before our interest is awakened.

From the genetic point of view interest follows attention; for it is not until after the organism gets a clear and definite awareness of the objects in its environment that it takes the attitude of interest toward them. Now, in the evolution of consciousness some states of awareness were accompanied by more feeling and more conation than others. These states of vivid awareness, with their accompaniments of feeling and conation, were the primitive states of interest. Certain things attracted attention, aroused feeling, and impelled to action. They were the things that were vitally beneficial or harmful to the organism. That is the reason they commanded the attention, and also the reason they became interesting when attention was given. And so we have come to call the things interesting that we attend to spontaneously. We should not, however, forget that attention has created the interest.

# CHAPTER IV

## SENSATION

**Sensation as an Element of Consciousness.**—When we examine our consciousness of the external world we find that it is very complex. Even the simplest thing has a large number of qualities. The rose has color, fragrance, form, and thorns, all of which may assail the different senses at the same time and are therefore present in our consciousness of it. We are never conscious of any one of these qualities alone. They always exist in combination. It is the business of psychology to analyze these complex experiences of the external world into their simplest elements, and to take account of them separately.

The simplest elements into which we can analyze our cognitive consciousness are *sensations*. Such experiences as color, smell, pressure, pain, and taste, which we, as psychologists, abstract from the larger conscious states in which we find them, and which we are unable to analyze into still simpler experiences, are sensations. If, for instance, we could attend to the redness of the rose alone, the color, abstracted from the form and material of the petals, from its relation to surrounding objects, from its position in space, from its unlikeness to the green leaves, would be a simple sensation. *Sensations*, then, are the immediate and unanalyzable elements of cognitive consciousness. Or, as Professor James puts it, "Sensation is the immediate result of stimulations before further knowledge or past experiences are awakened. Sensation is the basis of all knowledge. A being without sense-organs of any kind could never know anything of the world about him."

**Pure Sensations.**—It is evident that "pure sensations" are psychological abstractions, the result of psychological analysis. They are never realized in actual experience. It is said that pure sensations are possible only during the very first experiences of childhood. Afterward stimuli arouse more than the sensations themselves. Past experiences, suggestions of familiarity, relations of likeness and unlikeness, meanings, all these and more come along with sensations. However, it is necessary in our study to abstract sensations from the complexes in which they appear, and treat them as though they existed independently of the combinations in which they are manifest. For example, the rose arouses not only the sensation of red, but also awareness of its position in space, consciousness of familiarity, and many other factors which involve revived past experiences. Just the sensation redness cannot exist alone. However, at times, we may have sense-experiences which approach the simple quality of pure sensations. If some one should explode a giant firecracker under my chair quite unexpectedly, the very first brief instant of sense-impression I receive, before collecting myself sufficiently to have any suggestion as to the nature or position of the disturbance, would approximate a pure sensation. Immediately, however, as past experiences revive and mental syntheses begin to form, recognition both of the nature and the position of the disturbance would join with the simple sensation, making it a complex experience.

In view of this fact it is evident that ordinary observation of mental life must be supplemented by scientific treatment. Unless we consider sensation as simple and elementary and capable of being isolated for purposes of study, no scientific analysis of our sensory experiences can take place.

**Physiological Basis of Sensation.**—In all parts of the body, there are sensory surfaces supplied with sense-organs, which are connected by nerve-fibres with the sense centres in the brain. The vital organs, the articular surfaces, the muscle and tendon bundles, the skin, the mouth, the tongue, and the nasal cavities, the ear, the retinal surface of the eye —all have their own specific sensory nerve-endings which connect through chains of nerve-fibres with the brain. Some of these sense end-organs are affected primarily by conditions existing within the body, while the others are affected by objects outside the body. Whatever affects the sensory end-organs sets up nerve-impulses which are transmitted to the brain. Nerve-tissue possesses a characteristic known as *irritability of nervous tissue*, by virtue of which changes in one part of it are communicated to other parts. The sensory end-organs, connected as they are with the brain, form a rather extended system of reporting agencies which keep the central nervous system in touch with the happenings that are constantly taking place in the body and in the world of objects outside.

**The Nature of the Nerve-Impulse.**—Just what happens in a nerve that has been stimulated and is transmitting impulses the physiologist is at present unable to say. It is, however, certain that some form of energy is set up in the sense-organs by the action of the stimuli. This energy is then transmitted over the nerve-fibres. There is, however, no means of deciding whether its nature is mechanical, chemical, or electrical. An interesting question arises as to whether the nerve-impulses in the nerve-fibres from different sense-organs are the same in quality, or whether these fibres carry different specific energies to the brain. No matter how the optic nerve is stimulated, either by the light falling upon the eye, or by an electric current passing through the forehead, or by a blow upon the head, or by pressing upon the eyeballs, the result is a sensation of light. Similarly, each sensory nerve, however stimulated, gives rise to its own appropriate sensation when its impulse reaches the brain centre. We may interpret these facts in two ways: Either each kind of sensory nerve carries different impulses, or all sensory nerves carry the same kind of nerve-impulses. In the latter case the different forms of sensation which they arouse are due not to the impulses in the nerves themselves, but to the activities in the different brain centres. The first alternative is known as the theory of the *specific energy of nerves*. Modern physiologists are inclined to deny this theory. They hold that the "specific quality" belongs not to the peripheral nerve-impulses, but rather to the central brain processes. There is no physiological evidence of specific energies in different sensory fibres. So far as we know, there is no difference in kind between, for example, the impulses in the optic nerve and the impulses in the auditory nerve. On the other hand, it seems more reasonable to suppose that each sense-organ has a different mode of nervous action, and that its specific mode of action is transmitted to the brain by its nerve-fibres. However, in the present state of physiological knowledge, the question cannot be definitely answered.

**Evolution of Sense-Organs.**—There are some reasons for believing that the highly developed special sense-organs are the result of evolution—that they have developed in the course of racial growth from the primitive sensitive epithelial cells in the skin. In man the tactile sense is the nearest approach to the primitive epithelial sense in the lowest animal forms. The skin, or epithelium, is probably the earliest sense-organ. When, in the racial series, the differentiation from this primitive general sense toward the special senses began, it originated in a modification of the epithelial cells. These cells became elongated, with their peripheral ends turned toward the surface for the reception of the stimuli. From the other ends nerve-fibres were developed for transmitting impulses to other parts of the organism. Thus the sense-organs of smell, taste, and pressure were developed. Even in the cases where the sense-organs do not lie on the surface of the body, as in sight and hearing, the sensitive cells are developed from the epithelium. The auditory sense-organ of the higher animal forms may be traced back to an open auditory pit, like that of the crawfish. A higher form of the auditory pit is the auditory vesicle of the mollusk. Here the auditory vesicle bears upon its surface sensitive epithelial cells which are centrally connected. Within the vesicle is an auditory ossicle held in place by hair-like cells. In the vertebrates the auditory vesicle has developed into the sacculus and the utriculus of the ear. From the sacculus there has developed a spirally wound tube, the cochlea, while from the utriculus have grown the semicircular canals in the ear of man.

The sense-organ of vision has likewise undergone many transitional stages of development. The simplest form consists of a group of pigmented cells lining the walls of a depression in the skin. These cells are elongated, with one end turned toward the light and the other end drawn out in order to make proper nerve connections. Such a primitive eye is found on the tentacles of the limpet. A further development of simple eye-spots is found in some species of worms, where a light-concentrating apparatus has been evolved. The snail shows a still higher form. Here a simple retina with a protecting covering and a lens for focussing light-rays appear. The lens, however, is not sufficiently developed for forming images, so that the snail does not possess distinct vision. The next step is the perfecting of the lens, and where this has taken place there is close approximation to the eye of man.

In the tactile sense there has been a development from a sensitive epithelial cell provided with a hair shaft so placed that movement of the hair is communicated to the cell, to the tactual corpuscles of Meissner, a bulb-like formation of nerve-fibres found in the skin of man. The end-organs of cold and warmth have also been differentiated from the primitive tactile cells.

**The Stimuli.**—A stimulus is any force that acts upon a sense-organ. The forces which make up the various stimuli usually come from objects outside of the organism, but in certain cases they arise within the organism itself. Physiological changes may liberate forces which act upon sense-organs and give rise to sensations. Most of the organic sensations are set up in this way. Hunger, thirst, organic pain, etc., are caused by physiological changes within the organism.

The stimuli which affect the end-organs are innumerable, but they may be classified roughly into the following groups:

1. Mechanical stimuli.
2. Chemical stimuli.
3. Thermal stimuli.
4. Photic stimuli.
5. Electrical stimuli.

Mechanical stimuli consist in changes of pressure, such as those caused by objects coming in contact with the skin surfaces, or sound-vibrations beating against the ear. Chemical stimuli come from the chemical changes going on in food substances taken into the mouth, and possibly in odorous particles or in gases affecting the nose. Thermal stimuli are changes in the temperature surrounding the organism. Photic stimuli are light-vibrations (supposed to be ether-vibrations) affecting the eye. Electrical stimuli seem to be able to affect most, if not all, of the sense-organs.

With respect to their appropriateness or fitness to affect sense-organs, we may divide stimuli into *adequate* and *inadequate* stimuli. Adequate stimuli are those to which the sense-organs are fully adapted, while inadequate stimuli are those to which the sense-organs are not adapted. Light is an adequate stimulus for the eye; air-vibrations for the ear; warmth, cold, and pressure for the skin; soluble substances for the taste sense-organs, and gaseous particles for the smell sense-organs. On the other hand, light does not affect the ear nor air-vibrations the eye. They are therefore inadequate stimuli in these cases. While a blow on the head or pressure on the eye may result in light-sensations, such stimuli are, nevertheless, inadequate stimuli for the eye. In so far as a sense-organ is affected by inadequate stimuli, it gives rise to its own specific sensation.

What the real stimulus is is a question which transcends the limits of naïve thinking. Ordinarily we are in the habit of considering the object we experience as the stimulus. But careful consideration will show us the error of this way of thinking. We are never conscious of the stimulus itself. Light-sensations are the result of the vibrations of some form of energy (supposed to be ether) which acts upon the rods and cones of the retina. Sound-sensations are set up by air-waves falling upon the sensitive parts of the ear. But we are never directly conscious either of the air-waves or of the ether-vibrations themselves. So, through all the senses, the real stimuli that affect the sense-organs and set up sensory experiences are always beyond our direct observation, and so are never experienced themselves. We can only infer their nature. What these various forms of energy in the mechanical, chemical, thermal, photic, and electrical stimuli are is a problem for physics to solve. This consideration naturally raises the question of the nature of the objects which we experience. Physically, of course, we say that they are different forms of energy. But are they really what our experience reports them to be? Do they exist as we experience them, or are they something entirely different? Or do they exist only as our experience? Really, psychology is interested in and capable of deciding upon only one point raised in these questions. And that is that, whatever else the so-called object in the outer world is, it is at least our experience.

A still more complex situation confronts us when we consider that between the stimulus and the sensation there stands another form of objective existence (the nervous process in the brain), of which we are not conscious. We cannot sense the brain processes, for the brain is insensitive to its own activities. Here, again, we see that sensation depends upon something (the brain process) that is itself beyond our direct observation. Some curious theories have been advanced to explain how a material object is presented to consciousness. For instance, some of the earlier philosophers supposed that objects give off a kind of spiritual essence, or copy, which enters consciousness, and in this way objects reveal themselves to us. But we have overstepped the limits of psychology and are in the field of metaphysics.

**After-Effects of Stimulus.**—The length of time which a stimulus acts upon the end-organ and the duration of the resulting sensation are not the same. With respect to the stimulus, the sensation is retarded. Sensation does not start the instant the stimulus begins to act upon the sense-organ. This is due to the inertia of the nervous mechanism. A brief period is required to set the neural machinery in action. Even after the sensation begins it does not reach its maximum at once. This fact cannot be observed directly, but can be demonstrated in the laboratory. If a light of a given intensity is allowed to act upon the eye intermittently, so that each period of stimulation is very brief, the resulting sensation, although constant, is reduced in brightness, due to the fact that the stimulus acts for so short a time that the neural process is not raised to its maximum intensity.

In addition to the initial retardation of sensation, there is another discrepancy between the time of the stimulus and that of the sensation, namely, that the sensation continues for some time after the stimulus ceases to act on the end-organs. This finds its explanation in the fact that the activity of the end-organs continues after the stimulus is removed. Every child is familiar with the phenomenon of the continuous circle of fire caused by rapidly whirling a glowing ember. The retinal process in each part of the eye stimulated continues to act until the stimulus reaches that part again, giving the appearance of a continuous stimulus. A convenient way of demonstrating the continuance of sensation after the removal of the stimulus is to look steadily at the glowing wires of an electric-light bulb and then turn off the light, leaving the room dark. The sensation which is caused by the illuminated wires will continue for a time and may be projected to any part of the room. Blink the eyes and it stands out more clearly; close the eyes and the light may be seen located within the darkened field. The after-effects of stimulation are equally prominent in the cutaneous sensations. Touch the back of the hand with the point of a pencil and notice the after-sensation when the pencil is removed.

These after-sensations are commonly called "after-images," which term has been applied mostly to the visual sensations. Under some conditions the after-effects of the visual stimulus is the opposite of the primary sensation. If the after-sensation of the glowing electric-light filaments is watched with the eyes closed, it will presently change to an intense black projected against the dark field of the closed eyes. If the eyes are opened, it may be projected upon a white background as a dark image. If, after gazing at a bright window from a darkened part of the room, the eyes are tightly closed, a picture of the window will be seen in the retinal field, but the distribution of light and dark parts will be reversed. The sashes will appear light and the panes dark. If the eyes are not closed, the image of the window may be projected upon any white background. Here, as before, the light and shade are reversed. The after-effect of color-stimulation is seen in the complementary hue of the primary sensation. If, after fixating a yellow cross on a blue background for half a minute, one looks at a neutral gray surface, the cross will appear in a bluish tone upon a yellowish background. Such after-effects have been called "*negative after-images*," in contradistinction to the after-sensations which preserve the same qualities as the primary sensations, and which have received the name of "*positive after-images*."

An interesting effect due to negative after-images may be gotten by looking steadily at the dot in the centre of the circle in Figure 37 for forty seconds, and then quickly fixating the central part of a sheet of white paper. If the after-image does not stand out clearly, blink the eyes rapidly several times, still fixating the white paper.

**Sensory Adaptation.**—After a stimulus has acted for some time upon a sense-organ the resulting sensation is less fully experienced than it was at first. This lessening of the intensity of sensory impressions, which is due to the continued action of the stimulus, is known as *sensory adaptation.* Sensory adaptation shows itself most in the sense of smell and least in the sense of pain. Odors fade out very rapidly if they are continuously present to the sense-organs. Pain, on the other hand, loses very little of its intensity as we continue to experience it. All the other senses, however, show sensory adaptation. The pressure of glasses upon the bridge of the nose is felt quite distinctly when they are first put on, but after they are worn for a while the pressure becomes unnoticeable. A cold bath seems relatively less cold after the first plunge. A room which seems very brightly illuminated when we first enter it appears less bright after the first few minutes. We soon become accustomed to the sound of the ticking clock and fail to hear it. Attempts have been made to explain sensory adaptation by referring it to fatigue in the sense-organs or in the brain centres. While fatigue of the nervous tissue will certainly explain many cases of sensory adaptation, there may be other factors entering into the phenomenon.

Fig. 37.

Curiously enough, the term "adaptation" has another meaning in psychology. It is used to denote the increase of visual sensitivity in faint and bright illumination. On going from broad daylight into a darkened room, we are at first unable to distinguish objects clearly, but after a few minutes our ability to see increases. The eyes become accustomed to the faint illumination, or, as we say, they become dark-adapted. The same thing takes place when we go from a dark room into the broad daylight. At first the light is too strong. Not until we become accustomed to it are we able to see clearly. In this case the eyes become light-adapted. The student will have to determine from the context which of the two meanings is intended when the term "adaptation" is used.

**Attributes of Sensation.**—All sensations possess certain essential characteristics. The four most important are:

1. Quality.
2. Intensity.
3. Extensity.
4. Duration.

These characteristics do not reveal themselves to observation as being essential aspects of sensation in the same degree. For instance, it is plain that all sensations possess quality, intensity, and duration. But the case is not so clear for extensity. Auditory, gustatory, olfactory, and some of the organic sensations are thought by some psychologists not to have this attribute. It must be admitted that, if it is present in these sensations, it plays a more obscure part than the other attributes. We shall discuss the matter later.

**Quality.**—Quality is the unique and unanalyzable characteristic which gives sensations their psychic nature and marks them off into distinct mental existences. Any observable change in quality gives a new sensation. Psychologically, it is the most fundamental thing in sensory experience. The sensation red is qualitatively different from the sensation blue. Bitter is different from sweet, pressure from pain. We may consider that all sensations of red have the same psychic quality. All groups of sensations which show the same intimate sameness of experience may be thought of as having the same quality. Taste-sensations exist in four different qualities: sweet, sour, salt, and bitter; color-sensations also in four: red, yellow, green, and blue, each forming a single quality.

When we consider the whole field of sensations, we find that it falls apart into larger groups, or modes, and in such a way that the differences between the modes is markedly greater than the differences between the groups within the modes. All the visual sensations make up a single mode, the auditory sensations another, the gustatory sensations another, and so on. There is a decided break in the quality of the sensations when passing from one mode to another, as, for instance, when we pass from a sensation of taste to a sensation of color. Such a difference we may call a difference in modality. On the other hand, within a single mode we may pass from one group of sensations to another through a gradation of qualitative changes so slight that they escape observation, thus making the qualities appear to exist in a continuous series. Such a series is illustrated by the tonal qualities, where we may go from the lowest bass note to the highest treble along a single line of qualitative changes without a break. The visual sensations form another (although much more complex) system of sensation-qualities. The differences within these systems may be called differences of quality.

Although there is as yet no definite physiological evidence to settle the matter, we may suppose that the physiological basis for the quality of a sensation is to be found in the specific *kind* of nerve-activity aroused in the brain centres by the action of a specific kind of sense-organ.[1] Differences of modality in sensations are based upon the activity of different areas or centres in the cortex of the brain. Thus the visual sensations have their seat in the occipital lobes, while the auditory sensations have theirs in the temporal lobes.

**Intensity.**—Every sensation possesses some degree of intensity. The same sensation, without changing its quality, may vary in intensity from the weakest to the strongest. A sound may be soft or loud, a pressure-sensation may be light or heavy, and so sensations vary in intensity. We may suppose that the intensity of sensation depends upon the inten-

[1] See discussion of the "Physiological Basis of Sensations," p. 88.

sity of the neural activity in the sense-organs and the brain, and that the intensity of the neural activity is determined by the intensity of the stimulus. There is, then, an indirect relation between the intensity of the stimulus and the intensity of sensation. Within certain limits, the more intense the stimulus the more intense the sensation. The intensity relation between the stimulus and sensation may be modified by the condition of the sense-organs. If they are fatigued, or if adaptation has taken place, a given intensity of the stimulus will not occasion the same intensity of sensation as it would if the sense-organ were not fatigued or if adaptation had not taken place. A rose gives a more intense sensation of odor when first brought into the room, but after the sense-organ has become fatigued the sensation intensity is reduced.

The minimal and the maximal intensities of sensation mark two limiting points in the intensity series of any given sensation. The stimulus must reach a certain intensity before any sensation is aroused. A very weak stimulus fails to produce a sensation. The point at which the stimulus becomes strong enough to arouse sensation is called the *threshold of sensation*, or *lower limit of sensation*.[1] The point at which increase in the intensity of the stimulus fails to give further increase in the intensity of the sensation is called the *upper limit of sensation*. It should be noted in connection with the upper limit of sensation that, when stimuli become increasingly intense, other end-organs than those of the original sensation are affected. For example, a very loud sound, bright light, or intense pressure-stimulus will affect the pain-nerves. The presence of the resulting pain-sensation is not, however, to be taken as an increase in the intensity of the original sensation.

There is no way of measuring directly the intensity of a sensation. We can, however, compare like sensations and

[1] It is necessary for the stimulus to act for a certain length of time; a very brief stimulus may fail to arouse sensation, even though it may have an intensity far above the threshold.

say, for instance, which of the two is the more intense. In fact, we can arrange a number of such sensations in a series of intensities from the lowest to the highest. We can then measure the different intensities of the stimuli which occasion the sensations, and so have an indirect measure of the intensity of the sensation. We may start with a given stimlus, note the intensity of the sensation which arises from it, and then increase the stimulus until we are able to detect a "just-noticeable difference" in the intensity of the sensation. Continuing the process we obtain a series of sensations which are just-noticeably different in intensities, each sensation possessing a just-noticeably higher intensity than the one before it. Two interesting facts reveal themselves in such experimental procedure. If, for instance, we compare, by lifting successively, weights ranging from 100 grams to 105 grams, each differing from the other by one gram, we find that we are unable to sense the difference between the weight of 100 grams and those of 101, 102, 103, and 104 grams, respectively. Not until we reach 105 grams can we note an increase in the sensation, *i. e.*, increasing the stimulus does not bring an increase in the sensation until a certain increment to the original stimulus has been reached. This difference in the intensities of stimuli required to cause a just-noticeable difference in the sensation is called the *difference-threshold*.

The most probable explanation of this fact will be found in the nature of the physiological processes in the sensory end-organs and nerves. The nervous mechanism is such that a certain inertia of the end-organs must be overcome before an added increment to the nervous process can be set up. This resistance of the sense-organs to stimuli also explains the existence of the threshold, or lower limit, of sensation. A rough analogy may be seen in physical inertia. It requires more energy to start a piece of machinery than it does to keep it going after it is started, and more to change its rate of movement than to maintain the changed rate afterward. The difference-threshold expresses the increment or decrement which must be made to any stimulus before any difference in the sensation can be noticed.

The second fact is that equal increments to the stimuli do not produce a change of sensation at different parts of the scale of intensities. For example, it requires an increase of 5 grams to a 100-gram weight to produce a just-noticeable difference in the sensation. But if 5 grams are added to 200 grams, no difference in the resulting sensation can be detected. It requires an increase of 10 grams in this part of the intensity scale to cause a noticeable change in the sensation, *i. e.*, the difference-threshold varies for different parts of the scale. In general we may say that absolute differences in stimuli are more easily detected when the intensities of the stimuli are weak than when they are strong. One ounce added to two ounces makes a noticeable difference, but cannot be detected when added to ten pounds. A lighted candle brought into a dark room (low light-intensity) increases the illumination of the room very noticeably, but added to the high illumination of a brightly lighted room causes no noticeable difference in the illumination.

*Weber's Law* is an attempt to generalize these facts and state the relation of the intensity of the stimulus to the intensity of sensation more exactly. Briefly, it is as follows: *In order to obtain an increase in the intensity of sensation, the original stimulus must be increased by a constant fraction of itself.*[1] If, as has been stated, an increase of 5 grams to the stimulus of 100 grams is required to produce a just-noticeable increase in the sensation, and an increase of 10 grams for the stimulus of 200 grams, then the constant fraction is one-twentieth. In order, then, to increase the sensation of any weight-stimulus, the weight must be increased by one-twentieth of itself. The fraction which gives the just-noticeable difference of sensation is not the same for all senses. For simultaneous light it is one one-hundredth; for sound one-

[1] Fechner's modification of Weber's Law is as follows: Intensity of sensation increases as the logarithm of the stimulus.

fourth. These fractions can be obtained only by long and careful experimentation, and different investigators have obtained different values for the constant fractions. It has been found that they vary for different persons and for different parts of the intensity scale in the same sense. For very high and very low intensities Weber's Law does not hold at all. It applies only to the middle range of intensity values and even there only approximately.[1] It has not as yet been applied to sensations of temperature and taste. The most that can be said for Weber's Law is that it states a general fact of experience—the fact that sensation does not increase in the same ratio as the stimulus and, further, that in order to get an increase in the sensation-intensity, the increment to the stimulus must constantly be made greater and greater as we pass from the lower to the higher intensities. Or, to restate the same fact in another way, it requires a greater and greater difference in the intensities of two stimuli to produce a just-noticeable difference in the intensity of sensations, as we go from the lower to the higher intensities. The strict application of Weber's Law involves the assumption that all just-noticeable differences in the same class of sensations are equal, that the just-noticeable difference in the sensations produced by the stimulus of 100 grams and 105 grams is equal to the just-noticeable difference between the sensations produced by 200 grams and 210 grams. It would further assume that these differences are units of sensation, and that the total sensation in each case is made up of these units which may be added to, or subtracted from, the sensations. These assumptions have never been proved. There seems to be no reason for believing that a just-noticeable difference in sensations of low intensity is equal to a just-noticeable difference between sensations of high intensities. Nor can we observe, by the most careful introspection, any

[1] For a summary of the results of experimental investigations into the validity of Weber's Law, see Ladd and Woodworth: "Physiological Psychology," pp. 360–378.

evidence for the assumed fact that sensations are made up of intensity units, nor can we measure a sensation in such a way as to be able to say how many units of intensity it contains. Every sensation is itself, so far as we are able to say at the present time, a unit not capable of being broken up into smaller units.

Why it is necessary, in order to get a just-noticeable difference in sensation, to make increasingly larger additions to the stimulus as its intensity increases, raises a very interesting theoretical question. Is it due wholly to the nature of physiological processes in the end-organs and brain centres? Or is it due to purely psychological factors, such as the theory of the relativity of consciousness, which holds that the nature or value of every conscious state is determined by its relation to other conscious states? According to the principle of relativity, the intensity of a given sensation resulting from an increase in stimulus depends upon the intensity of sensations already going on, or sensations just preceding. We cannot go into these questions at this time further than to call attention to these possible interpretations of the facts summarized by Weber's Law.[1]

**Extensity.**—*Extensity* is to be distinguished from *extension.* Extension is experienced only as the result of combining simpler experiences (distance, direction, and position) into a mental complex. Extensity is an original and native aspect of sensation—a kind of "bigness" within which there are no parts or divisions which can be distinguished from other parts. If first the head and then the point of a pin are pressed very lightly upon the forefinger, so that the point of the pin does not stimulate the pain-nerves, the two pressure-sensations will seem different. The difference is that of extensity. The sensations are without any space form, for there is no distinguishing of parts, yet they possess different

[1] For a statement of these theories or interpretations of Weber's Law, see Ziehen: "Physiological Psychology," pp. 54–61; Ladd and Woodworth: "Physiological Psychology," pp. 374–9.

degrees of native "bigness" or extensity. It is difficult to isolate this attribute of sensation, because it is so overlaid with the higher and more complex experiences of space perception. Extensity shows itself to introspection rather as the bigness of the sensation than as the size of objects or spaces suggested by the sensations. It attaches itself more closely to the intrinsic nature of the sensation than do experiences of extension. The visual sensations, the cutaneous sensations, the articular and muscular sensations, all plainly have the extensity attribute. On the other hand, sounds, tastes, and smells have been denied extensity by some psychologists, although some, chief among them James, believe that *all* sensations possess extensity. The roar of a lion is bigger than the squeaking of a mouse; the low bass note sounds bigger than the high treble note.[1] Some smells, like the heavy odor of musk, seem more voluminous than the lighter ones, such as the odor of camphor; the taste of sweet is more voluminous than the taste of sour. Some pains are bigger than others. The fine, shooting pain of neuralgia is less voluminous than the heavy soreness of a boil, says James.[2] The extensity differences in the sensations of hearing, taste, and smell are evidently not so great as they are in the sensations of the skin, the muscles, and the eyes. This more limited range of experienced difference in the former group of sensations may explain the obscure part that extensity plays in them.

The physiological basis for the differences of extensity in sensations lies in the differences in the number and outspread of nerve-endings. The greater the number of nerve-endings stimulated, the greater the degree of extensity in the resulting sensation. In the skin and on the retina of the eye we have extended nerve-elements, which are capable of being stimulated in different numbers. The stimulation of these

[1] For James's discussion, see his "Principles of Psychology," Vol. II, p. 134; "Briefer Course," p. 335.

[2] "Briefer Course."

nerve-elements gives an attribute of spread-outness which varies with the size of the area and number of nerve-elements stimulated at any one time. The nerve-endings in the ear are not spread out, while those of the tongue and nose are normally stimulated in such a way as to give little opportunity for the experience of extensity differences.

**Duration.**—Every sensation begins, rises to its fulness, and then wanes. These phases are really not differentiated from each other in ordinary experience, yet they furnish the basis for a simple experience of duration which is present in all sensation. This sensory attribute must be distinguished from the duration-of-time perception, which, like extension-in-space perception, is the result of the synthesis of different sensations. Duration as an attribute of sensation is part and parcel of the sensation itself. It must not be confused with the *perception* of how long the sensation lasts. It is the sensation content of temporal outspread or temporal bigness, a native time quantum. Even the shortest sensation possesses this native duration attribute.

**Other Attributes.**—Besides the four attributes just discussed, other attributes have been suggested as essential characters of sensation. Titchener[1] mentions clearness as an attribute. Sensations may appear in the foreground or in the background of consciousness, in the focus or in the margin. Now, since a sensation must appear somewhere between these limits, it always possesses some degree of clearness. Münsterberg[2] gives the name "vividness" to this attribute, and cautions his readers against confusing vividness of sensation with intensity. He says: "If the ticking of a clock in my room becomes less and less vivid for me the more I become absorbed in my work, till it finally disappears, it cannot be compared with the experience which results when the clock to which I give my full attention is carried farther and farther away." A sensation of low intensity

[1] "Text-Book of Psychology," p. 53.
[2] "Psychology and Life," p. 86.

may have a high degree of clearness or vividness, while a sensation of high intensity may have a low degree of clearness or vividness. The changes in clearness or vividness seem to be due not to sensation alone, but to changes in attention.

There is sufficient evidence to believe that every cutaneous and visual sensation possesses a particular local significance, which is different for every part of the skin and retina stimulated. Close your eyes and have some one touch you with the point of a pencil, first on the right and then on the left hand. You are able to tell without hesitation which hand is touched. This means that each sensation, although alike in all other attributes, differs for different regions of the skin stimulated. This difference in sensation is a difference of *local sign*. If, however, two points of the skin which lie very close together are stimulated, the difference of local sign disappears. When the two near points are stimulated simultaneously, the two stimuli are felt as one. When the distance is sufficiently great, however, the stimuli are discriminated and felt as two. This is because the difference in their local signs is great enough to distinguish one from the other. The minimal distance of separation of two stimuli which are sensed as two is termed the "two-point threshold."

This threshold varies for different parts of the skin. It is smallest for the tip of the tongue, lips, and fingers, and greatest for the regions along the spine. The local-sign difference of sensation is not a difference of space perception, in which points are located with reference to each other, and given definitely perceived distances and directions between them. It is simply a felt difference in sensations coming from different points of the skin surface. It is possible to find regions within which the two points of a compass are felt as different, and yet no perception of the distance or direction of the points from each other is present. In such cases there is merely a local-sign difference in the sensations. The nearer the points are together the more the sensations are alike;

the farther the points are apart the more definite the difference in the local sign.

Visual sensations also possess local significance. Sensations which are alike in every respect (in quality, intensity, etc.), but which come from different points of the retina, are sufficiently unlike to enable us to distinguish the stimuli which occasion them. Here, as in the skin, every point of each retina gives a sensory character different from the character of every other point.[1]

## Kinds of Sensations

Psychological analysis has shown that the old common-sense classification of the sensations into the five senses of seeing, hearing, tasting, smelling, and feeling (touch) is inadequate. There are many more than five senses. The sense of "touch," for instance, has been resolved into the four distinct senses of pressure, pain, cold, and warmth. Each one of these has its own particular kind of nerve-endings which give, when stimulated, a unique sensory experience, different from all others.

Obviously we shall get different divisions of the sensations if we classify them according to the stimuli which occasion them, or according to the sense-organs to which they correspond, or according to the intrinsic quality of the sensations themselves. A thoroughgoing classification of the sensations based upon the different kinds of stimuli which occasion them is impossible, because, in many cases, we do not know the exact nature of the stimulus which acts upon the sense-organ. Such is the case in the sense of smell. Without, however, going into the exact character of the stimuli, we may divide the sensations into three classes,

[1] Every point in one retina has a corresponding point in the other. Sensations from these points have the same local significance. This is demonstrated in cases where two stimuli exactly alike, but occupying different positions in space, are not distinguished from each other. This is illustrated in stereoscopic vision, where two pictures occupying different positions in space are seen as a single picture.

according as their stimuli are found (1) in the vital organs of the body, (2) in the bodily organs of locomotion, or (3) in objects external to the body.

1. Organic Sensations (reporting conditions of the internal bodily organs).

2. Kinæsthetic Sensations (reporting movements of the body).[1]

3. Special Sensations (reporting the character of external objects).

If we classify the sensations according to their different sense-organs, and at the same time subdivide them into groups according to their intrinsic qualities, we have the following classification:

1. Organic Sensations:
   (*a*) Sensations from the alimentary canal.
   (*b*) Sensations from the respiratory organs.
   (*c*) Sensations from the circulatory system.
   (*d*) Sensations from the sex-organs.
2. Kinæsthetic Sensations:
   (*a*) Muscular, sensations from moving muscles.
   (*b*) Tendinous, sensations of pull and strain in tendons.
   (*c*) Articular, sensations of gliding and pressure in joints.
   (*d*) Sensations from vestibule and semicircular canals: sensations of position, change of movement and dizziness.
3. Cutaneous Sensations:
   (*a*) Pressure.
   (*b*) Pain.
   (*c*) Cold.
   (*d*) Warmth.

[1] The kinæsthetic sensations are sometimes classified under the organic sensations. For instance, Titchener, in Baldwin's "Dictionary of Philosophy and Psychology," classifies the organic sensations into: (1) Muscular sensations, (2) alimentary sensations, (3) sexual sensations, (4) static sensations, (5) respiratory sensations, and (6) circulatory sensations. The muscular and static sensations of Titchener's classification are in this text-book placed under the kinæsthetic sensations.

4. Olfactory Sensations:
   (Many sensations, but no characteristic groups of qualities have been made out.)
5. Gustatory Sensations·
   (*a*) Sweet.
   (*b*) Sour.
   (*c*) Salt.
   (*d*) Bitter.
6. Auditory Sensations:
   (*a*) Noises.
   (*b*) Tones.
7. Visual Sensations:
   (*a*) Achromatic (brightness).
      White.
      Gray.
      Black.
   (*b*) Chromatic (color).
      Red.
      Yellow.
      Green.
      Blue.

The classification here given is not at all satisfactory from the psychological point of view, but it is the best that can be made at the present time. In the first place, some of the subheadings signify elementary sensory experiences which cannot be further analyzed, as for instance those of pressure, pain, warmth, and cold; while others, like those under Organic and Kinæsthetic Sensations, signify highly complex experiences, *i. e.*, are made up of simpler sensations. The so-called sensations of hunger, thirst, and nausea from the alimentary canal, the sensations from the sex-organs, the muscular, tendinous, and articular sensations may not present any distinct sensory qualities at all, but may be nothing more than certain combinations and blends of pressure, pain, and temperature sensations. Or, at least, they may be primitive and undifferentiated forms of these sensations.

# CHAPTER V

## ORGANIC, KINÆSTHETIC, AND CUTANEOUS SENSATIONS

### Organic Sensations

The organic sensations include a great mass of undifferentiated and vague sensory experiences that are located in and about the vital organs. From the visceral or abdominal region come dull internal pains of varying intensities, vague sensations of fulness, tension, and pressure. From the upper part of the alimentary canal we get the more definite experiences of hunger, thirst, and nausea. Hunger is located in the stomach as a dull, gnawing pain or ache. Thirst is felt quite definitely in the back part of the mouth, and in the throat as an insistent pressure combined with a sense of roughness and dryness. Nausea is felt in the œsophagus and stomach, and is difficult to analyze into its constituent elements of sensation. In the thoracic region we sometimes experience a sense of a want of air, stuffiness, or, even more intensely, suffocation, due to the physiological condition of the lungs when shut off from an adequate air-supply. The sensations coming from the acts of respiration arise from the intercostal muscles and diaphragm, and should be classed among the kinæsthetic sensations. While, ordinarily, we do not sense the condition of the heart, yet in fright, anger, and other emotions, and also during and after extreme physical exertion, sensations arise in the cardiac region. In fright there is a sinking sensation, caused probably by the sudden change in the heart's action. In anger and heavy physical exertion there appears a vague, rhythmic tension about the heart. The "heart jumping up in the mouth" probably comes from the sensations of muscular contraction in the pharynx. The sex-organs add another group of sensations to the organic experiences. The organic experiences, so far mentioned, are without doubt highly complex products, compounded out of simpler sensations. If analysis were not so difficult here, we should probably be able to resolve these experiences into sensations very much akin to those of pressure, pain, cold, and warmth of the cutaneous sensations. The stimuli which set up these organic experiences consist in the physiological condition of the organs themselves, which affects the sensory nerve-endings, and thus gives rise to the experience. In cases where vital organs are not supplied with sensory nerves, any serious disturbance in such organs is experienced as pain in neighboring sensitive tissue.

It is interesting to note that some of the ancient writers located the feelings and emotions in the vital organs, and modern investigators have pointed out more definitely the close connection between the vague and unanalyzable organic sensations on the one hand and the feelings and emotions on the other. The condition of the vital processes has much to do in determining the nature of the emotional tone. Indigestion will predispose one to a pessimistic and gloomy point of view, while a healthy digestion tends to cheerfulness. Ordinary speech has several expressions which recognize the idea that the emotions are based upon organic conditions and disturbances: "The bowels of compassion," "the complacency of a full stomach," "the bile of one's wrath," "the emotions of the heart," "his heart is in his work," etc. Even among psychologists the theory has been entertained that the feelings are unclear and undifferentiated organic sensations[1]—diffuse organic experiences that arise from the stimulation of unspecialized nerve-endings, and therefore do not stand out clearly in consciousness with definite sensory qualities as do the other groups of sensations. It is certainly true that many of the organic sensations are obscure, very

[1] Titchener: "A Text-Book of Psychology," § 74.

vaguely located, refer to the organism as a whole rather than to any definitely distinguishable part of it, and consequently appear as subjective modifications or attitudes. On the other hand, the special sensations refer to the characteristics of objects that appear to exist independently of our consciousness. Many of the organic sensations are altogether unprojected, *i. e.*, have no reference beyond themselves, suggest nothing over and above the subjective experience itself. All these characteristics make the more obscure organic sensations strikingly similar to our feeling or affective experiences. However this may be, the organic sensations furnish a continuous and constant accompaniment or background of all mental experiences. We are never free in normal waking life from this undertone of inner bodily experiences.

### Kinæsthetic Sensations

**Muscle, Tendon, and Joint Sensations.**—The muscles, tendons, and articular surfaces are supplied with sensory nerve-endings which give, when stimulated, sensations of movement. These sensations, together with the sensations that arise from the vestibule and semicircular canals of the inner ear, are known as *kinæsthetic* sensations.

The sensory end-organs consist of muscle-spindles and tendon-spindles in which fine branchings of nerve-filaments lie next to or coil about the muscle and tendon fibres within the spindles. Other nerve-endings—Pacinian corpuscles and end-bulbs—are found in the muscles, tendons, joints, and periosteum. It is probable that they, too, have to do with the sensations of movement.

The stimuli which excite these nerve-endings are the contraction and relaxation of the muscles, the pull and tension of the tendons, and the gliding of the tendons over the joints, and possibly the pressure of the joint surfaces against each other.

The muscle, tendon, and joint sensations are blended with the cutaneous sensation of pressure whenever we move any part of the body. The cutaneous sense is stimulated when the body changes its position by the folding, stretching, or pulling of the skin. In order to study the kinæsthetic sensa-

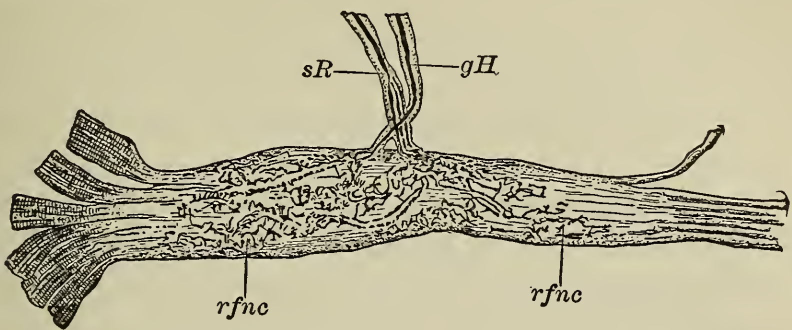



FIG. 38.—Tendon with nerve-plaque made up of the endings of sensory fibres seen entering from above. *rfnc*, arborization of the sensory fibres.

(From Ladd and Woodworth, after Ciaccio.)

tions alone, we must find some way of isolating them from the skin sensations. This may be done by making the cutaneous tissue anæsthetic by the use of cocaine or ether spray.

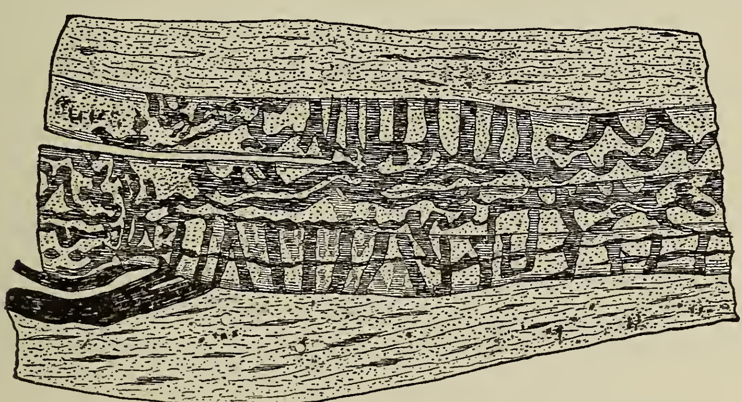


FIG. 39.—Nerve-plaque in a muscle-spindle. The nerve-fibre entering at the left subdivides to form the network shown.

(From Thorndike's "Elements of Psychology," after Barker.)

It is almost impossible to separate the muscle, tendon, and joint sensations from each other, for the reason that most movements awaken all three at once. But those who have had practice in introspection may be able at times to pick out these different sensory experiences from each other. By gripping the hand tightly, one gets a dull internal pressure-like sensation in the muscles of the forearm. Practically the same sensation may be obtained by pressing upon the muscles of the arm with the hand. The sensation will stand out more clearly if the skin surface has been previously made anæsthetic.

The tendon sensation appears when one lifts a heavy weight by pulling directly upward with the arm and allowing the weight to hang perpendicularly from the shoulder. While the sensation in question is qualitatively different from the muscle sensation aroused at the same time, we are unable to describe it further than to say that it is a sensation of pull or strain in the wrist and elbow joints.

The joint or articular sensations are not so clearly made out as the muscle and tendon sensations. But if the left forefinger is grasped firmly between the thumb and the first two fingers of the right hand and pressed inward while the finger is bent back and forth at the middle joint, a smooth, gliding sensation will be experienced which seems very much like a light internal pressure. One must disregard the cutaneous pressure caused by grasping the finger by the other hand.

As a proof that these sensations really play the chief part in our perceptions of movements and positions of the limbs, we may point out the fact that complete anæsthesia of the skin surface does not interfere materially with the ability to perceive the position and movement of any member of the body, while anæsthesia of the joints or of the muscles and tendons seriously interferes with such perception and reduces the power of making co-ordinated movements.

We shall see later, when we take up the combination of sensations into space perceptions, that a large part of the raw material out of which these perception complexes are formed is drawn from the kinæsthetic sensations. We depend very largely upon these sensations for the conscious material out of which we construct our space world. Not only the sensations which arise in the larger muscles and their adjacent joints and tendons, but the finer muscles controlling convergence, divergence, and accommodation in the eyes furnish conscious elements which are combined with the tactual and visual sensations into definite space perceptions.

It is important that the student should bear in mind from the beginning that these sensations—in fact, all sensations—are only the psychological elements out of which the complexes of perception and other higher mental processes are built up. These sensations must be thought of only as simple qualities of consciousness, and never as the more highly developed perceptions of weight, definite perceptions of position, direction, or distance. These latter experiences are complexes of sensations which we gain through experience by associating and combining the elementary sensations in various ways.[1]

**Sensations from Vestibule and Semicircular Canals.**—A set of rather obscure and unobtrusive sensations arises in the vestibule and semicircular canals of the ear. With slight stimulation of these organs, it requires very careful introspection to detect their presence in consciousness. They appear as swimming sensations in the head, dizziness, sensations coming from the position and sudden change of the movement of the head, or the body as a whole. They play an important part in maintaining the position and equilibrium of the body. The movements which restore disturbed equilibrium are known as "compensatory movements." They are present in nearly all animals. If, for instance, the body is forced from its upright position, when such a position is advantageous or desired, immediately the compensatory reflexes throw the head and body back to their normal positions. In cases of extirpation of the vestibule and semicircular canals in animals the sense of equilibrium is lacking,

[1] See Titchener: "A Text-Book of Psychology," §48 and §50.

as is shown by the loss of compensatory movements, disturbed locomotion, running in a circle, unusual positions of the head, etc. Deaf-mutes, whose internal ear, including the vestibule and canals, is destroyed, do not experience the sensations of swimming in the head, or dizziness when rotated in a revolving chair, or when whirling on the heel.[1] These facts point to the vestibule and semicircular canals as containing the sense-organs for the sensations under discussion. The vestibule and semicircular canals form the upper part of the internal ear, the lower part of which is the cochlea, the true sense-organ of hearing.

On the inner walls of the membranous semicircular canals, and within the utricle and saccule of the vestibule, are tufts of hair-like cells projecting into the endolymph, a fluid which fills the canals. The hair-like cells in the utricle and saccule support a number of crystal-like formations, or otoliths, which are held in place by a gelatinous substance. About the base of these hair-cells and those in the semicircular canals are distributed the nerve-endings of the vestibular nerve, whose fibres connect with the cerebellum.

The stimulus which acts upon the hair-cells consists in the varying pressure of the endolymph, which bends them whenever any change of position or movement of the head takes place. The canals of the ear lie in different planes, one horizontal and two vertical, at right angles to each other. The position of the canals is such that any movement of the head will cause the endolymph to act upon the hair-cells in one or more pairs of canals. Head movements will cause a lag or back-flow of endolymph in the canals, thus bending the hair-cells in an opposite direction to the movement and so exciting the nerve-fibres. Therefore, turning rapidly upon the heel will cause swimming sensations in the head in the direction of the movement. The sensation will continue

[1] Deaf-mutes depend upon visual sensations for sensory cues to position and equilibrium. When their eyes are closed or blindfolded, they show a decided disturbance of the sense of position and equilibrium.

until the fluid in the canals affected takes up the motion of the head. Then they will cease. If movement is suddenly arrested, and we stand still after whirling upon the heel, we experience the swimming sensations in the direction opposite to the original movement, because when we stop the endolymph continues, for a time, its movement forward, and so bends the hair-cells in the direction of the original movements and reverses the sensation. The direction of the swimming sensation may be changed from the horizontal to the vertical plane by inclining the head on the shoulder during rotation, and then raising it to an upright position when the rotation is stopped. We then get the swimming sensations in the vertical directions. Under these conditions, when the head is bent down upon the shoulder the vertical canals are brought more nearly into the plane of rotation, and consequently the endolymph in these canals is affected more by the movement of rotation than in the others, with the result that the sensations correspond in direction to the plane of the canals.

With a little practice the student may learn to observe the swimming sensations during and just after sudden movements of the head in any direction. The more intense of these sensations are commonly known as sensations of dizziness, or rotation.

The hair-cells in the utricle and saccule are weighted with otoliths, which make them still more sensitive to the different positions of the head. These otoliths drag down upon the hair-cells, pulling in the opposite direction to any change of position. By exerting varying tensions in different directions, according to the position of the head and body, vague pressure-sensations are set up which serve as indices of position, equilibrium, and locomotion.[1]

[1] For a more complete treatment of the sensations of the vestibule and semicircular canals, see Ladd and Woodworth: "Elements of Physiological Psychology," §34, §35, and §36, pp. 208–212. Titchener: "A Text-Book of Psychology," §§51–55, pp. 173–182.

## Cutaneous Sensations

An object placed against the skin surface arouses a number of sensations, all at the same time: sensations of pressure, warmth and cold, and, in some cases, pain. Although by careful observation we can readily distinguish the different qualities of these sensations from each other, we usually think of the combined effect of all these sensations of the skin as the "sense of touch." The experiences which we get from this so-called "sense of touch" are not simple experiences. Hard and soft, smooth and rough, wet and dry, sharp and blunt, round and cubical, are the result not of a single sense, but of combining different cutaneous sensations. Even the muscular and articular sensations may be part of these complex experiences.[1]

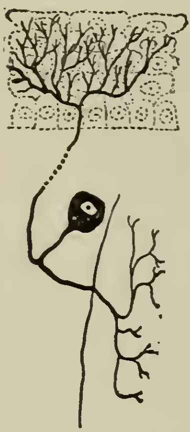


Fig. 40.—Diagram showing the nerve-endings in skin. (Retzius.)

(Taken from Quain's "Elements of Anatomy.")

The experiences which we get from the skin as a whole need to be analyzed into their elements, and so, in the following sections, we shall treat of each cutaneous sense alone.

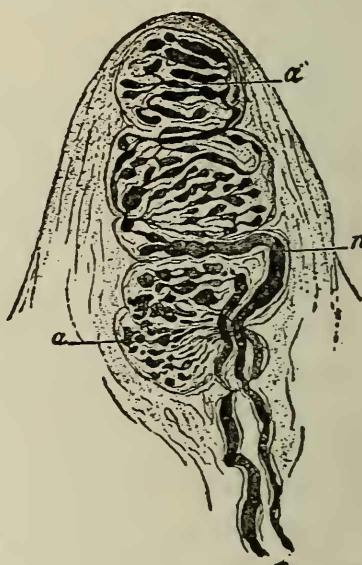



Fig. 41.—Corpuscle of Meissner: *n*, sensory fibre; *a*, its branching termination within the corpuscle.

(From Ladd and Woodworth, after Ranvier.)

**The End-Organs.**—The cutaneous sense areas consist of the skin, lip surfaces, lining membrane of the mouth and throat cavity, conjunctiva and

[1] See Titchener: "Text-Book of Psychology," p. 171, §50, and Ladd and Woodworth: "Physiological Psychology," p. 347, §26.

cornea of the eye. In these areas and in the tissue immediately underneath are several kinds of nerve-endings, showing various terminal formations.

About the roots of the hairs which are found on a large part of the skin surface are coiled the terminal branches of sensory nerves. These are stimulated by touching the hairs, or the skin on the "windward" side of the hairs. In the papillæ or among the epithelial cells of the palms, soles, and lip surfaces, where hairs are not present, are a large num-

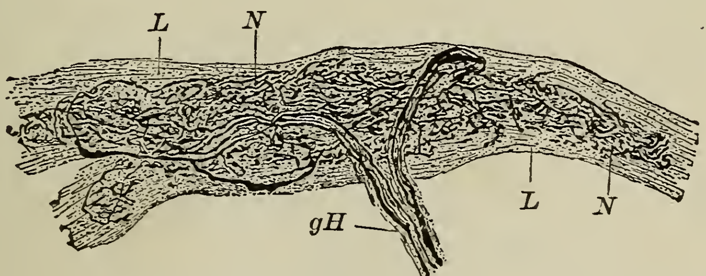



FIG. 42.—Plume-organs of Ruffini with the sensory fibre's arborization. (From Thorndike's "Elements of Psychology," after Barker.)

ber of tactile nerve-endings, called "Meissner's corpuscles." Each corpuscle consists of a small, oval body, about which nerve-fibres intertwine and then, entering the interior of the corpuscle, end in small enlargements. To the nerve-endings about the hair-roots and the corpuscles of Meissner is ascribed the sense of pressure.

The simplest form of end-organ is that of the "*free nerve-endings*," consisting of nerve-fibres which have lost their medullated sheath and lie between the epithelial cells of the epidermis. They have been found, also, in the cornea of the eye, where the sensation of pain is very prominent. The free nerve-endings are the end-organs for pain.

In the deeper layers of the skin are found cylindrically shaped bodies with very finely divided nerve-fibrils, forming a small plume-like structure. They are known as the "*plume-*

*organs of Ruffini*," and to them is attributed the sense of warmth.

From the fact that the "*end-knob of Krause*" (consisting of a small spherical body of granular matter, into which unmedullated nerve-fibres pass and end in a coiled mass), is found in the conjunctiva of the eye, which possesses sensitivity to cold, but not tactile sensation, and in the mucous membrane of the mouth, which is especially sensitive to cold, it is argued that the "end-knob of Krause" is the sensory end-organ for cold.

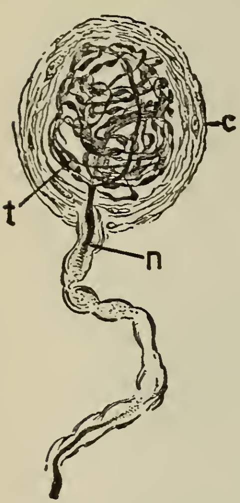



Fig. 43.—End-knob of Krause: *n*, sensory fibre; *t*, its branching termination within *c*, the capsule.

(From Ladd and Woodworth, after Dogiel.)

The "*Pacinian Corpuscles*" found in the subcutaneous tissue may possibly serve as the sense-organs for heavy pressure, as distinguished from the lighter pressure of the skin.

The suggested correlation of the different cutaneous sensations to definite nerve-endings cannot be taken as final. The evidence at best is only indirect. Even where the evidence seems convincing, there are some perplexing facts. For instance, the "tactile corpuscles" are very numerous in just those parts of the skin which are most sensitive to pressure, and very few or practically absent from parts of the skin where this sense is dull. This seems to be good evidence for assuming that the "tactile corpuscles" are the sense-organs for pressure. But it has been proved that some parts of the skin that possess sensitivity to pressure are lacking in this particular kind of end-organ. Of course, it may be that some of the senses have more than one form of nerve-ending.

**The Brain Centres.**—*The cortical centres* for the cutaneous sensations are in the region along the fissure of Rolando, in the so-called somæsthetic area. This area constitutes the brain centre for the "muscle-sense," as well as the centre for the cutaneous sense. (See Figure 28.) The exact boundary of the somæsthetic area is not yet made out clearly. Most physiologists place it in the region just posterior to the fissure of Rolando, opposite and corresponding to the motor centres which lie on the anterior side of the fissure. Within the somæsthetic area the skin of the feet and legs is represented by the upper part of the area, the skin of the trunk and arms by the middle part, while the head is represented by the lowest part. So that, with respect to the cutaneous sensations, a man may be said to stand on his head in his brain. A lesion in this region, on one side of the brain, is attended by a loss of all the cutaneous sensations (except pain) on the opposite side of the body. The centre for pain has not been located.

**Pressure-Sensations.**—If an object is pressed upon the skin surface lightly, the resulting sensation of pressure is different in quality from the sensation aroused by a more intense pressure contact. The latter sensation has a dull, heavy quality, akin to a slight ache. It appears to come from the underlying muscles and is probably the result of excitation of sensory nerves among the muscle-bundles. We shall, accordingly, distinguish between "*light pressure*" and "*heavy pressure.*"

If any portion of the skin surface (say a half-inch square on the volar side of the forearm) is completely explored with the end of a soft bristle (a horsehair 2 cm. long) that will bend easily and will, therefore, not exert too strong a pressure, it will be found that certain parts of the area do not respond with any sensation at all. But certain other parts, "pressure spots," will respond with a clear-cut sensation of pressure. These pressure spots appear to be permanently located. They are distributed in an irregular manner and vary very much for different parts of the skin. They are most plentiful in the finger-tips, where the corpuscles of Meissner are found in large numbers. On the hairy parts of the skin a pressure spot is usually found on the windward side of each hair, just over the hair-root, or follicle. They are also found on the surfaces between the hairs. They react when the skin is pulled or stretched, as well as when pressure is applied. This punctiform character of the pressure surfaces is shared by all the other cutaneous senses. Within the same area we shall find pain spots, cold spots, and warm spots. The warm spots are fewest in number, while the pain spots are most numerous; the pressure and cold spots are equally numerous on most skin areas.

It must be remembered that the pressure spots can be discovered only by light pressure. If the pressure upon any point of the skin is increased the skin is indented, causing neighboring sensitive areas to react so that any point of the skin is sensitive to ordinary pressures. This explains why pressure appears to be continuous. Pressure-sensation arises not only from pressure applied to the skin surface, but from the muscle-bundles and from the joint surfaces, when they are pressed together. This we may call "heavy pressure."

The acuity or delicacy of pressure-sensations, as measured by the lightest pressure-stimulus that will cause a just-noticeable sensation, varies for the different parts of the skin. It is most acute for the tips of nose, tongue, lips, finger-tips, and forehead, and bluntest for the loins, the shins, and the soles. It requires from twelve to sixteen times more pressure to excite a minimal sensation on the latter surfaces than it does on the former.

The "two-point threshold," or just-noticeable local difference, also varies for the different parts of the skin. On the tip of the tongue the points of a compass may be sensed as two when they are 1 mm. apart; on the finger-tip, 2 mm.; on the outer surface of the lips, 5 mm.; the inner surface, 20 mm.; on the back of the hand, 30 mm.; along the spine, 54 mm.

**Pain-Sensation.**—As in pressure, so in pain sensations, we can distinguish between the cutaneous pain-sensations and the dull subcutaneous ache. Pain is very widely distributed, coming from nearly all parts of the body. There are some exceptions. Certain portions of the visceral and other vital organs are devoid of all sensation. A small area on the inner side of each cheek is insensitive to pain-stimuli. On the other hand, the cornea of the eye seems to possess only pain-sensations, or at least the threshold of pain is so low that no other sensations can break through the sensory experience of pain when the cornea is stimulated. From the fact that pain-sense is so widely distributed in practically all parts of the body, it has generally been regarded as a "common sensation," with no specific end-organs. It is now thought, however, that cutaneous pain arises from the stimulation of the "free nerve-endings."

The *pain spots* are very numerous in all parts of the skin. If, with the point of a fine needle or a stiff-pointed bristle, we explore a small area on the back of the hand, which has been previously explored for pressure spots, we shall find that the pain spots outnumber the pressure spots very greatly. There may be over one hundred pain spots to the square centimetre in some parts of the skin. The most sensitive of these pain spots may be located very readily. Care should be taken to put the point of the needle down gently, and always with the same intensity.

Impulses set up by pain-stimulation require a longer time to reach the cortical centres than those from pressure-stimulation. Or, at least, the latent period, or the period of retardation of pain-sensations, is longer than in that of pressure-sensations. Strike the back of the hand smartly with a lead-pencil. Notice that the sensation of pressure appears first, then an instant later the sensation of pain. This suggests that the nerve-impulses from the pressure and pain end-organs are conducted to the brain centres along different paths. There is pathological evidence to support such a theory.

The after-images of pain remain longer than those of pressure, and there is much less adaptation in pain than in pressure. We do not "get used" to pain-sensations as we do to pressure. The higher intensities of pain are much more insistent than other sensations. They command attention and crowd out the other contents of consciousness.

The sensation of pain should not be confused with the *feeling* of unpleasantness which, in common speech, is often designated by the terms "pain" and "painful." This confusion arises from the fact that nearly all pain-sensations are unpleasant. While it is exceedingly unpleasant to lose one's purse, there is necessarily no pain-sensation involved in the experience, although we commonly speak of it as "painful." But pain as a sensation and pain as a feeling are entirely different experiences. We shall refer to this distinction again when we discuss the feelings.

**Sensations of Cold and Warmth.**—The sensations of cold and warmth are often erroneously thought of as different degrees of a single sense. They are, really, distinct sensations of entirely different qualities, and they arise from the stimulation of separate nerve-endings. The tendency to think that they belong to the same sense is probably aided by the fact that temperature, as a physical condition, is a single, unbroken continuum. The further fact that the sensation of cold seems to pass gradually into the sensation of warmth through a point of indifference, or zero, augments the tendency to think of them as different degrees of the same kind of sensation.

Both cold and warmth sensations appear on the skin surfaces in the same punctiform manner as do pressure-sensations. The warm spots are somewhat less numerous than the cold spots, while the cold and pressure spots are about the same in number for any given area. If a blunt-pointed stylus of metal, having a temperature of 15 degrees C. (59 degrees F.) is drawn lightly across the inner surface of the forearm, in addition to the pressure-sensation sudden flashes of cold will appear. (The point of a lead-pencil will stimulate some of the more sensitive cold spots.) The spots where these cold sensations appear are arranged in irregular groups and chains. Sometimes isolated spots may be found. A curious fact is met with when the stylus is heated to 45 degrees C. (113 degrees F.), or above, and placed upon a cold spot. The spot will respond with a perfectly definite sensation of cold. This is called the "paradoxical sensation of cold."

When the stylus is heated to from 37 degrees C. to 40 degrees C. (99 to 104 degrees F.) the warm spots may be located. The sensations of warm seem more diffuse and are located with more difficulty than cold-sensations. They also come to full intensity more slowly than the cold-sensations, which appear very promptly when the stimulus is applied. When the stylus is heated to 50 degrees C. (122 degrees F.) the pain spots respond with the sensation of pain.

The so-called "hot sensation" is a combination of warm and cold sensations, while "burning hot" is a combination of warm, cold, and pain. "Biting cold" is a combination of cold and pain. These complex sensory experiences are aroused when surfaces of extreme temperatures (above 45 degrees C., or 113 degrees F.; or below 12 degrees C., or 53 degrees F.) are applied to the skin. It is a common observation of every-day life that, under certain circumstances, we often momentarily confuse very hot and very cold. A very hot water-pipe may be sensed at the first instant that the hand comes in contact with it as icy cold. The following diagram will show the relations of cold, warm, and pain sensations to each other.

Temperatures of from 30 degrees C. to 36 degrees C., being near the physiological zero, appear to the skin indifferent or neutral. If the temperature is lowered the stages of cool, cold, and biting cold are successively passed through. At 12 degrees C. the sensation of pain appears, and rises very rapidly with further decrease of temperature. If the temperature is gradually raised from physiological zero, the stages of lukewarm, hot, and burning hot are experienced. At 45 degrees C. cold (paradoxical cold) is added to the warm sensations and continues for the temperatures above. At 50 degrees C. pain is added to the complex and gives the

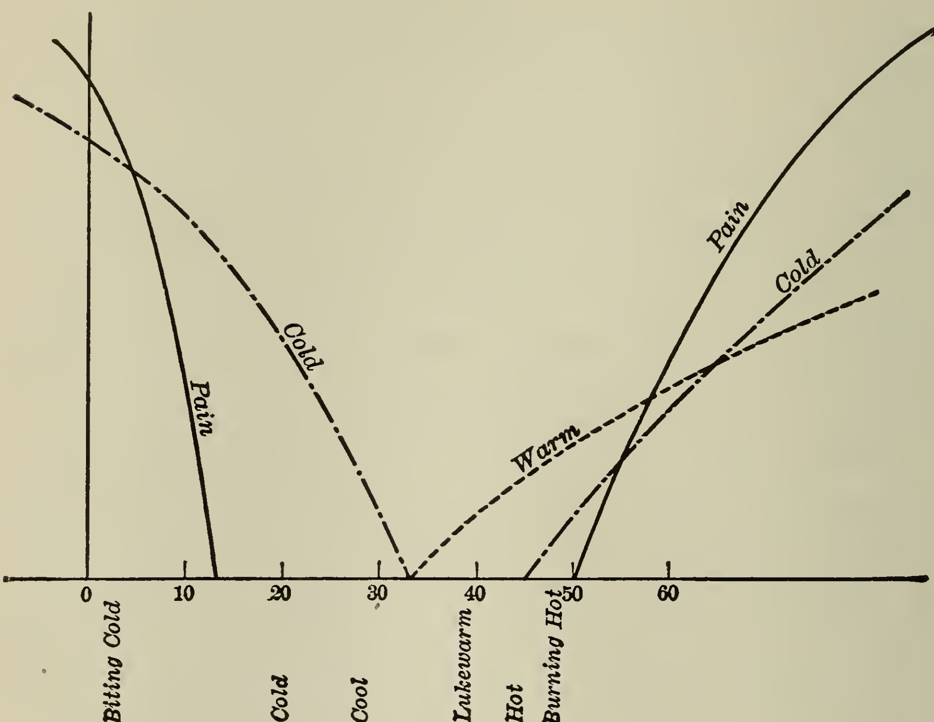



Fig. 44.—Diagram showing the relations of cold, warm, and pain sensations to each other. The figures on the base line indicate the temperature in centigrade.

(From Pillsbury's "Essentials of Psychology," after von Frey.)

experience of burning hot. Only between 36 degrees C. and 45 degrees C. is the warm sensation unmixed. Likewise, only between 30 degrees C. and 12 degrees C. are the cold sensations unmixed.

Sensations of cold and warmth may be aroused by organic processes within the body. In fever and chills, temperature-sensations are set up by pathological organic disturbances. They may also be aroused in emotional experiences, as in fear, shame, etc. The application of certain substances, like mustard, pepper, menthol, and alcohol to the skin gives sensations of temperature.

Adaptation of the temperature end-organs to cold and warm stimulation is very marked. We easily adapt ourselves to varying degrees of temperature. Different parts of the bodily surface are constantly subjected to different temperatures, as, for instance, the tongue and the forehead, yet the experiences of temperature arising from them are not different. A room that seems warm when we first enter will shortly become indifferent if we remain. Likewise a room that seems cold at first appears warmer as we become accustomed to it. It seems that any portion of the skin may, within certain limits, become temporarily adapted to different temperatures so that they appear indifferent. Fill three bowls with water of different temperatures, one at 20 degrees C. (68 degrees F.), one at 30 degrees C. (86 degrees F.), and the remaining one at 40 degrees C. (104 degrees F.). The water at 30 degrees will feel indifferent, neither warm nor cold. Place one hand in the water at 20 degrees C. and the other hand in the water at 40 degrees C. Leave them there two minutes, then plunge both hands in the water at 30 degrees C. This will feel decidedly warm to one hand and cold to the other. To explain this fact, viz., that the same absolute degree of temperature in the stimulus may sometimes cause the sensation of cold and sometimes the sensation of warm, we may suppose that the physiological zero, or indifference-point of the skin, has been raised in one case and lowered in the other, and that any temperature above the physiological zero will arouse sensations of warm, while any temperature below the physiological zero will arouse the sensations of cold.

Recent physiological investigations of the effect of severing certain sensory nerves supplying a given area of the skin upon the cutaneous sensations of that area show conclusively that the sensory nerves which carry impulses from the subcutaneous tissues are separate from the sensory nerves supplying the skin surface.[1] In these investigations the radial and external nerves of the left arm were cut, and then the part of the cutaneous area from which these nerves lead was subjected to rigid experimentation. The most conclusive result was that, while practically all the superficial cutaneous sensations were lost, the subcutaneous sensations of heavy pressure and pain (dull ache) and kinæsthetic sensations were not destroyed by the operation. There remained crude localization of heavy pressure, but no discrimination of two points or the shape of objects. This indicates that the nerve-fibres for these senses run with the deeper-lying motor nerves. The psychological implication points to the complete separation of the subcutaneous and cutaneous senses.

Careful exploration of the cutaneous surface during the process of recovery or reuniting of the severed nerves showed that there are two systems of cutaneous senses. During the first stage of recovery cutaneous pain and temperature sensations from extremes of heat and cold (above 45 degrees C., or 113 degrees F.; and below 20 degrees C., or 68 degrees F.) returned. There was, however, during this stage no sensibility to light pressure, or to moderate degrees of temperature between 25 degrees C. (77 degrees F.) and 40 degrees C. (104 degrees F.), *i. e.*, no warm and cold sensations of low intensities could be aroused, although the higher intensities of cold and warm were present. In this stage of recovery only the more intense stimuli aroused sensations. This system of sensory experiences was given the name of *protopathic sensations*. Some months later, as recovery proceeded, another set of sensations appeared: light touch and moderate degrees of cold and warm sensations of temperatures ranging from 25 degrees C. to 40 degrees C. Accurate cutaneous localization and ability to recognize two points and the shape

[1] Rivers and Head: "A Human Experiment in Nerve Division," in *Brain*, 1908, vol. XXXI, p. 323.

of objects reappeared with this group of sensations. These were called the *epicritic* sensations. The protopathic warm and cold were punctiform, while the epicritic were non-punctiform. The protopathic sensations responded only to strong intensities of stimulation, while the epicritic responded only to light stimulation. It was therefore concluded that the protopathic senses were more rudimentary and not so highly developed as the epicritic. While this investigation adds much to our knowledge of the cutaneous sensations, it is doubtful whether it proves the existence of two distinct forms. Franz[1] has shown that the transition from the protopathic to the epicritic sensibilities is gradual. It may well be that the so-called epicritic sensations are simply refinements of the cutaneous sensations.

Certain pathological conditions in the nerve-pathways of the spinal cord and nerve-root furnish interesting dissociations of the cutaneous sensations. In some diseases the sensation of pressure from more or less definite parts of the skin surface is lost, while sensations of pain and temperature remain. In others all sensations of temperature and cutaneous pain are destroyed on extended areas, leaving the sensation of cutaneous pressure intact.

[1] *Journal of Comparative Neurology and Psychology*, 1909, vol. XIV, pp. 107, 215.

## CHAPTER VI

## OLFACTORY AND GUSTATORY SENSATIONS

### Olfactory Sensations

**End-Organ.**—The sensitive area, *regio olfactoria*, for the sense of smell is located in the upper part of the nasal cavity, somewhat removed from the air-currents of ordinary breathing. Only by sniffing can the full force of the olfactory stimuli be brought to the sensory nerve-endings. The regio olfactoria is hardly as large as the surface of a dime (250 sq. mm. in each nasal chamber). In this area are found the sensitive olfactory cells, lying between supporting epithelial cells and bearing tufts of from six to eight cilia upon their peripheral ends. These cells are true nerve-cells, upon which the stimulus acts directly. They extend to the surface of the limiting membrane through which the cilia pass in order to be exposed to the olfactory stimuli. Any abnormal condition of the mucous membrane will disturb the proper functioning of these sensitive cells. A severe cold in the head will be accompanied by almost complete loss of the sense of smell. Catarrhal conditions of the nasal passages will impair the sensitivity of this sense.

The fibres from the sensitive olfactory cells connect with other neurones which pass to the olfactory lobes, the lower brain centre, which in turn sends fibres to the gyrus uncinatus of the hippocampal lobes, which constitute the cortical or higher centre for the olfactory sense.

**The Stimulus.**—It is a curious fact that we do not know definitely what the stimulus is which excites the olfactory cells and arouses the sensations of odor. It is very probable that odoriferous substances reach the end-organs in gaseous form. Substances that give out odor must therefore emit small gaseous particles which reach the olfactory region and there set up chemical reactions, which differ in character with the different substances. The variation in the chemical reactions would then (so far as the stimulus is concerned) account for the differences in olfactory sensations. This theory does not help us very much, for the different chemical reactions set up on the mucous membrane of the nasal surfaces have not yet been determined.

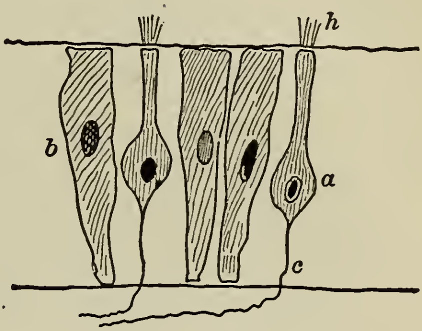



Fig. 45.—Diagram showing cells in regio olfactoria: *a*, olfactory cell, with *h*, projecting hairs; *b*, supporting cells; *c*, nerve-fibre.

Another theory proposes that the gaseous particles give off very short ether-waves, caused by their intramolecular vibrations, and by means of these waves stimulate the sensitive nerve-cells. In this case the kind of olfactory sensation aroused would depend upon the character of the intramolecular vibrations, which in turn depend upon the vibrations of the atoms or groups of atoms within the molecule. It has been discovered that certain substances having similar molecular structure possess similar odors. But, on the other hand, some substances with widely different constitutions are similar in odor. At present it is impossible to make any thoroughgoing correlation between the molecular structure of odoriferous substances and the qualities of olfactory sensations. However, some interesting facts have come out of the investigations into the chemical nature of odorous substances. For instance, it has been found that practically all odorous substances contain elements belonging to only three groups in the periodic system of classification (Mendelejeff's groups). They are the fifth, sixth, and seventh groups. If similar substances derived from the elements of one of these groups are arranged according to their molecular structure, their odors will form a series of related odors which shade off from one to the other. As an illustration, we may arrange fatty acids in the following order: formic ($CH_2O_2$); acetic ($C_2H_4O_2$); propionic ($C_3H_6O_2$); butyric ($C_4H_8O_2$); valerianic ($C_5H_{10}O_2$); caproic ($C_6H_{12}O_2$). The odors from these substances are similar, but change gradually as we pass along the series. The higher acids formed from these elements (stearic, $C_{18}H_{36}O_2$) have little or no odor.[1] Chlorine, bromine, and iodine give off odors that can also be arranged in a series of similar experiences.

**Classification.**—The fact that we know so little about the stimuli has stood in the way of classifying the many different olfactory sensations. The number of elementary olfactory qualities is unknown. As yet no satisfactory classification has been made. Whether all odors may be reduced to a few elementary kinds, or whether they must remain as they are now, a chaotic mass of sensory experiences, only the future will reveal.

The classification of olfactory sensations into two kinds, agreeable and disagreeable, is based upon the feelings which accompany the sensations, and not upon the quality of the sensations themselves. It is therefore of little value.

The modification of the Linnæus table of olfactory groups by Zwaardemaker is practically the only classification of odors that we have at the present time:

1. *Ethereal Odors:* Fruits, wine, ether, beeswax.
2. *Aromatic Odors:* Spice, lavender and anise, lemon, cedar wood, rosewood, almond.
3. *Fragrant Odors:* Flowers, vanilla, balsam.
4. *Ambrosial Odors:* Musk and amber.
5. *Alliaceous Odors:* Onion, asafœtida, dried fish, chlorine, iodine.

[1] Haycraft, *Brain*, 1888, p. 166; 1889, p. 160. Schäfer's "Text Book of Physiology," 1900, II, p. 1254.

6. *Empyreumatic Odors:* Burned substances, tar, gasoline, creosote.

7. *Hircine Odors:* Cheese, rancid butter, lactic acid.

8. *Repulsive Odors:* Narcotics, certain insects.

9. *Nauseous Odors:* Decaying animal matter.

The list is not complete. There are many odors which will not go under the nine headings, and it is evident that the different classes are not elementary in nature. At present the only hopeful indication of a successful classification of the olfactory sensations is the suggestion that substances of a similar chemical nature give similar odors. Something may be done by putting together in a single class all sensations aroused by each group of closely related chemical substances. By working over the field carefully the fundamental uniformities and differences in the qualities of olfactory sensations may be discovered.

Many olfactory stimuli, besides arousing their own true olfactory sensations, excite also other concomitant sensations which are blended with the olfactory sensations and are often confused with them. Ammonia, for instance, affects all parts of the mucous membrane in the mouth and throat, giving a stinging or tingling tactile sensation besides the smell proper. Likewise, nauseous stimuli arouse the sensations of nausea, which are mixed with the true olfactory sensations. In the study of olfactory sensations these accompanying sensory elements must be analyzed out and disregarded.

The threshold of olfactory sensations is very low. A hound following the trail of game or his master's footsteps by the sense of smell, a bird-dog discriminating the different odors of "live" and "dead" birds, suggest the delicacy of this sense. Man's olfactory sense is not so acute as that of the dog, but nevertheless it is sharp enough to detect slight traces of known substances too small to give chemical reactions. Camphor, 1 part to 400,000, and musk, 1 part to 8,000,000, can be detected by the sense of smell. In order to be sensed at all, substances must be composed of molecules having a certain minimum weight. There is some individual variation, but for most persons any substance whose molecules possess a weight less than those of prussic acid is odorless.

Adaptation to olfactory stimuli takes place very rapidly. We soon fail to notice the odor of a badly ventilated room. Odors that are very marked at first gradually fade out if the stimulus is continued. If camphor-gum is held to the nostrils for a few minutes the decrease in the intensity of the odor can be noticed before the end of the first minute. If the stimulus is allowed to act long enough, it will become inodorous. One laboratory subject gave the following results: asafœtida became odorless in 1 minute and 17 seconds; peppermint in 6 minutes; heliotrope in less than a minute; camphor in 1 minute and 34 seconds; iodine in 54 seconds.

This adaptation of sense-organs to continued stimulation has sometimes been attributed to fatigue. But whether we have to do with a positive process of adaptation or a negative one of fatigue is difficult to determine.

The fact that, when the olfactory sense-organs become adapted to a certain odor, certain other odors also fail to arouse sensation, while others are sensed without impairment, indicates that different olfactory stimuli have similar physiological effects. This sameness of physiological effect might very well be taken as a suggestion for the classification of odors. Odors which have the same effect in fatiguing or adapting the sense-organ might be considered as belonging to the same class. If the nose is fatigued for iodine, it becomes thereby fatigued also for alcohol, heliotrope, and possibly other odors, while the odor of ethereal oils is not lessened at all.

It may be that the olfactory nerve-endings are differentiated, and that a given stimulus acts upon only one kind of end-organ, without affecting others. The phenomena in *partial anosmia,* a pathological condition in which the subject, while possessing in other respects normal olfactory sensations, is lacking in ability to sense certain odors, point also to differentiated end-organs. It is, however, improbable that certain nerve-endings are set apart for a certain kind of stimulus alone; rather, if there is differentiation, it is simply that certain nervous elements in the olfactory region are more sensitive to some odors than to others.

Many of the great variety of odors which we experience are the result of combination and fusion of odors. Odors may combine in such a way that we are able to detect the presence of each one in the combined result. Or odors may fuse and form a new odor, in which the component parts are not detected. Under some circumstances certain odors will not combine or fuse, but rather suppress each other. For instance, the odor of carbolic acid suppresses the odor of putrefaction. If two different odors which suppress or "compensate" each other are presented through the olfactometer, one to each nostril at the same time, the phenomenon of rivalry is set up. We sense first one and then the other alternately. Contrast effects are also present among odors. For instance, it has been found that after smelling cedar wood for a short time the odor of india-rubber becomes noticeably more distinct.

Sensations of smell are very rich in associations. They are also effective in arousing feelings, moods, and emotional attitudes. The fact that incense plays an important part in certain religious rites and ceremonies is interesting in this connection. The æsthetic value of perfumes is due to the relation of sensations of odors and the feelings.

It is thought that the sense of smell is degenerating in man. It is pointed out that man's sense of smell is much less acute than that of the lower animals, and that while the olfactory lobes, the lower centre for smell, make up the larger part of the brain in some of the lower animal forms, in man they have dwindled into insignificance. Certainly, in man, the importance of this sense has become relatively less prominent. To the animal that must track its prey or scent the presence of its enemies, or find its mate, it is the chief food-getting and race-propagating sense. But man has risen above this primitive method of sense-guidance, and has come to depend more and more upon the more highly developed senses. The olfactory sensations, however, still stand guard over the selection of foods and aid in the detection of noxious and injurious surroundings. They also contribute no inconsiderable part to the character of what we ordinarily consider the sense of taste. Taste and smell are so closely related that without critical psychological analysis we fail to discriminate the elements supplied by the sense of smell to the complexes which masquerade under the name of taste.

## Gustatory Sensations

On account of the very close relation between the sensory experiences which come from the nose and the mouth, and because the tongue surface is also capable of giving rise to sensations of pressure, temperature, and pain, as well as gustatory sensations, we rarely ever experience the quality of taste alone. Our so-called sensations of taste are complexes of taste proper, smell, tactile, temperature, and in some cases weak pain sensations. It is a common observation that while we are suffering from a severe cold in the head we lose most of our taste-sensations. It is not taste proper, however, but the odor of food substances which is lost, and which we have confused with taste because it blends so closely with it. All substances taken into the mouth excite tactile sensations. Temperature is usually present, and a few substances, like charged beverages, arouse slight pain-sensations. So, ordinarily, what we accept as taste is a compound of several kinds of sensations. It is a difficult task to analyze out of these complexes the true sensations of taste.

If the nostrils are stopped so that no air passes through them, one is unable *to taste* the difference between many different substances, such as tea, coffee, solutions of quinine, etc. The subject should be blindfolded and the solutions should be of equal strength, but not strong enough to arouse tactile sensations by the astringent quality of the solutions. The student will be surprised to find how blunted apparently the sense of taste is when smell is eliminated. Much of the flavor of fruits, the bouquet of wines, and many other so-called taste qualities are contributed by the sense of smell.

**End-Organ.**—The end-organs for gustatory sensations are the taste-buds found chiefly in the papillæ of the tongue, but also on the surface of the soft palate, the fauces, and epiglottis, and even in the larynx. Taste-buds are small oval bodies resembling a bud in structure and occupying little pit-like cavities in the epithelium. These cavities open out into the mouth through small apertures called "gustatory pores." Through these pores food substances in solution enter and stimulate the taste-buds. The highly modified epithelial cells which make up the taste-bud are of two kinds, the supporting cells—long and tapering—and the gustatory cells which occupy the more central part of the taste-bud. The gustatory cell is a spindle-shaped cell whose outer end terminates in a fine, hair-like process which projects through the gustatory pore. It was formerly thought that its inner end was continuous with a true nerve-fibre, but this is not true. The sensory nerve-fibres enter the base of the taste-bud and, dividing into many branches, end about the body of the gustatory cell. Outside the taste-buds are found other nerve-endings which minister to the cutaneous sensations of pressure, cold, warmth, and pain, which are also present in the mouth surfaces. On the tongue the taste-buds are found on the sides of the circumvallate papillæ, in the fungiform papillæ, and in the furrows between them. The filiform papillæ do not contain taste-buds. It is estimated that there are from 100 to 200 taste-buds in each one of the circumvallate papillæ.

The gustatory cells are without doubt the sensory end-organs. The hair-like processes are stimulated by the soluble substances. The impulses set up are communicated through the body of the cell to the endings of the sensory fibres which terminate about these cells.

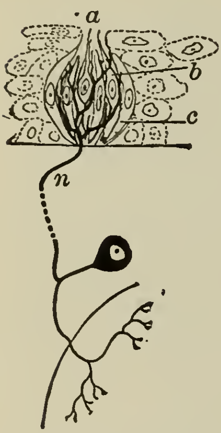


Fig. 46.—Diagram showing a taste-bud and the nerve-endings: *n*, nerve-fibre, *a*, gustatory pore; *b*, gustatory cell; *c*, supporting cell. (Retzius.)

(From Quain's "Elements of Anatomy.")

**Gustatory Nerves and Brain Centres.**—The back part of the tongue, the location of the circumvallate papillæ, is supplied by sensory fibres from the glosso-pharyngeal or ninth cranial nerve, while the front part receives sensory fibres from the lingual branch of the trigeminal or fifth nerve. So far as can be determined, the cortical centres for gustatory sensations are in the inner sides of the hemispheres in the hippocampal lobes, near but posterior to the olfactory centres.

**Stimulus.**—All gustatory stimuli must be soluble. A perfectly insoluble substance is tasteless. It does not follow, however, that all soluble substances have taste; some do not. A sapid substance, not in liquid form, may dissolve in the saliva after being taken into the mouth, and so reach the taste-buds, where it sets up a chemical change. There seems to be no consistent relation between the chemical nature of substances and the taste-sensations which they arouse. Substances of very different chemical constitution arouse the same taste-sensations.

The question of whether mechanical stimulation of the tongue arouses taste-sensations is in dispute. Apparently vague sensations of taste can be aroused by tapping the tip of the tongue. There is no doubt of the fact that electric currents passed through the tongue excite taste-sensations. The positive pole of a battery tastes decidedly sour and the negative pole is slightly bitter. Whether this is due to the direct effect of electricity upon the taste-buds, or is the result of electrolysis in the saliva which might free acid and alkaline ions, is not known.

**Classification of Gustatory Sensations.**—The gustatory sensations may all be reduced to four elementary or simple sensations:

1. Sweet.
2. Sour.
3. Bitter.
4. Saline.

Alkaline and metallic sensations have been proposed, also, as elementary taste-sensations, but they are thought by some experienced observers to be compounds: alkaline being a combination of salt and sweet, and metallic of salt and sour. Even sweet, sour, bitter, and saline sensations, as we know them in our ordinary taste experiences, are not simple or pure. The sensation aroused by salt has, in addition to its taste, a slight burning sensation which is tactual in its origin. The tactile sensation may be aroused alone by solutions of salt too weak to arouse the taste of salt. Sour or acid sensations have an astringent quality which is not due to taste. Sweet has a smooth, almost oily quality, which can be isolated, as can the other non-gustatory qualities mentioned, by applying the stimuli to tasteless regions of the mouth—the middle of the tongue or the hard palate.

Whether the four elementary gustatory sensations have special taste-buds in each case is not known. We do not know definitely whether an individual taste-bud will respond to only one or to four kinds of stimulation, and so produce the nerve-excitation for one or for four kinds of sensation. We do know that there is a partial surface differentiation of the tongue for the four taste qualities. For instance, the circumvallate papillæ at the base of the tongue are more sensitive to bitter than to the other qualities. The tip of the tongue is more sensitive to sweet and salt and less sensitive to sour and bitter, while the sides of the tongue are especially sensitive to sour. (The central portion of the tongue in adults has been found completely lacking in taste-sensations, although possessing those of the pressure, thermal, and pain senses.) Some experimental results of stimulating individual papillæ with sweet, sour, bitter, and saline, indicate that the taste-buds may be differentiated. It has been found, for instance, that some of the papillæ respond to only one kind of stimulation, others to two, others to three, and still others to all four.[1] Where a single papilla gives out only one kind of sensation, it seems probable that it contains taste-buds of one kind only. Pathological cases of partial ageusia, or loss of taste, have been reported in which one or two of the taste qualities are lacking, while the others are not affected. Certain drugs will destroy some of the elementary gustatory sensations without interfering with the others. The leaves of the plant *gymnema sylvestre* will, when chewed, cause the loss of sensations of sweet and bitter, while salt and sour remain. If a proper solution of cocaine is placed upon the tongue it will affect the taste-sensations separately: first bitter is lost, then sweet, then salt, and finally sour. Another fact of interest in this connection is that some substances will arouse different tastes on different parts of the tongue; sodium sulphate is salty to the tip and bitter to the base of the tongue, while a certain form of saccharine is sweet to the tip and bitter to the posterior part of the tongue. All these facts would not be difficult to explain if we were certain that the taste-buds are differentiated, so that a single bud responds with only one kind of sensation.

**Retardation.**—The initial period of retardation differs slightly for the four qualities of taste-sensations. Salt is the quickest and bitter the slowest in responding after the stimulus is applied. This may be due either to the chemical nature of the stimulus, or to the manner in which the end organs respond, or even to the central cortical processes.

[1] Oehrwall: *Skandinavisches Archiv f. Physiol.*, 1890, II, p. 1. Kiesow: "Wundt's Philosoph. Studien," 1898, XIV, p. 591.

**Mixtures, Contrasts, Adaptation.**—The mixing of two taste-stimuli may result, in some cases, in the sensations remaining separate and distinct from each other, although both are present in consciousness; in others, the sensations may alternate, first one and then the other appearing, or they may tend to neutralize or compensate each other. Salt and bitter, if not too intense, may exist side by side. If, however, the intensities of taste-sensations are high, there is a tendency toward rivalry. The neutralization or compensation of tastes is very familiar: the taste of sugar will neutralize the bitter taste of coffee, or the sour taste of claret. There seems, however, rarely to be a complete neutralization between compensating tastes. The nearest approach is that set up between sweet and salt. If salt is added to a weak sweet, an insipid, flat taste, neither sweet nor salt results, which amounts almost to the absence of taste-sensation. Compensation is least noticeable between sweet and sour, while salt and bitter, sour and bitter, sour and salt, and sweet and bitter manifest it in increasing degrees as we pass from one pair to the next. There is sometimes a marked degree of neutralization between tastes and smells; the nauseating odor of castor-oil is offset by the sour taste of lemon-juice, or the bitter taste of quinine is partially neutralized by the aromatic odor of essence of orange-peel.

Contrast effects are also present in gustatory sensations. The sour taste of fruit appears more intensely sour after honey has been taken into the mouth. Contrasts (both simultaneous and successive) may be observed between salt and sour, and salt and sweet. If the tip of the tongue is stimulated first with a salt solution, then thoroughly rinsed and dried, a very weak solution of sweet, which cannot be tasted normally, tastes decidedly sweet. Even distilled water, which is ordinarily tasteless, will appear sweet after salt stimulation. Salt appears to bring out the sweet. The same effect may be obtained by simultaneous stimulation of the two sides of the forward part of the tongue: salt applied on one side will increase the effect of a weak solution of sweet on the other. Contrast effects in bitter have not been established. A bitter sensation which lies just below the threshold cannot be brought out by simultaneous stimulations of sweet, sour, or salt.

Adaptation of the sense-organs of taste is not as marked as in the case of the olfactory sense. It is, however, noticeable in our every-day experiences. Food which at first seems very sweet will, if we continue to eat it, decrease in intensity. A solution of salt will appear less salty as we continue to taste it. It may be that some of the successive contrast effects mentioned above are due to adaptation. When, for instance, the sour of fruit is increased after honey is eaten, the adaptation of the sense-organs to the honey may make them less able to taste the sweet in the fruit and, consequently, its acid quality will stand out more plainly.

**Threshold.**—The temperature of sapid substances affects the threshold of gustatory sensations. Extremes of cold and warm lessen the sensitiveness of the taste-organs. To get the maximum effect, taste-stimuli should be of moderate temperatures. Hot soups and cold beverages sacrifice the true gustatory sensations, and minister to the tactile and temperature-sensations in the mouth, and the olfactory sensations in the nose. The total complex effect may be enhanced, but taste-sensations are lessened thereby. What the weakest sensation of taste is for any given substance can be determined only by the strength of solution necessary to arouse a just perceptible taste-sensation. The salt of sodium chloride can be tasted upon the tip of the tongue when the solution is 0.25 gm. to 100 c.c. of water; sweet of sugar on the tip of the tongue, 0.50 gm. to 100 c.c. of water; bitter of quinine on the base of the tongue, 0.00005 gm. to 100 c.c. of water; sour of hydrochloric acid on the sides of the tongue, 0.007 gm. to 100 c.c. of water. There are some individual variations among different subjects, but these results hold for any one having a fairly acute sense of taste.

**Complexes.**—In the beginning of this discussion we called attention to the blending of sensations of taste, smell, tactile, temperature, and pain sensations. Before leaving the subject we may again call attention to the need of critical psychological analysis when dealing with the so-called tastes of every-day life. Some of these so-called tastes are really not tastes at all. The pungent "tastes" of spices are almost altogether odors, astringent tactile sensations, and temperature-sensations, sometimes mixed with slight intensities of pain. Tea and coffee owe their distinguishing characters to odor and astringent tactile sensations. Many food substances, like nuts and vegetables, are distinguished in the mouth by their consistency, which appeals to pressure-sensations. Peppermint is hardly a taste at all; there is very little left when the sensations of cold and smell are eliminated. The so-called oily tastes are tactile in nature.

This tendency of sensations to blend and combine into complex experiences is present everywhere in the sensory realm, but the taste and smell sensations furnish such a striking illustration of the coalescing nature of consciousness that it is well to emphasize the point at this time.

# CHAPTER VII

## AUDITORY SENSATIONS

Auditory sensations belong to two great groups: sensations of *noises* and sensations of *tones*. Noises are caused by the irregular, non-periodic vibrations of air particles set up by objects in the outer world. Tones, on the other hand, are caused by regular, recurrent, periodic vibrations of air particles. Here, as in all the other sense realms, the real elementary qualities of sensations are obscured in every-day experience by the combinations and complexes in which they appear. For instance, the apparently simple sound of a single piano note is made up of at least two or more discriminable tonal sensations, which we can isolate with a little practice in careful observation. In order, then, to get at the component elements of our experiences of sound, we must analyze these experiences critically. In the case of auditory sensations we can make a much larger use of the knowledge of physics than we have heretofore. Happily, the physicist's knowledge of the nature of the stimuli for the sense of hearing—resounding bodies and the air-waves which they propagate—is of great value in breaking up the compounds of auditory consciousness into its elements. We are further aided by the advanced stage of physiological and anatomical knowledge of the inner ear—the sense-organ of hearing.

**End-Organ.**—The inner ear is a twofold organ of sense. One part of it, the cochlea, transforms air-vibrations into sensations of sound; another part, the vestibule and the semicircular canals, yields sensations of movement and equilibrium. This latter part we have already treated under kinæsthetic sensations. It is, therefore, the cochlea, the winding snail-shell of the ear, that commands our attention as the organ of hearing proper. The outer ear, composed of the pinna and the external auditory canal, and the middle ear [shut off from the external ear by the tympanic membrane, or drum, and containing small ear-bones (*malleus*, *incus*, and *stapes*) controlled by two small muscles (*tensor*

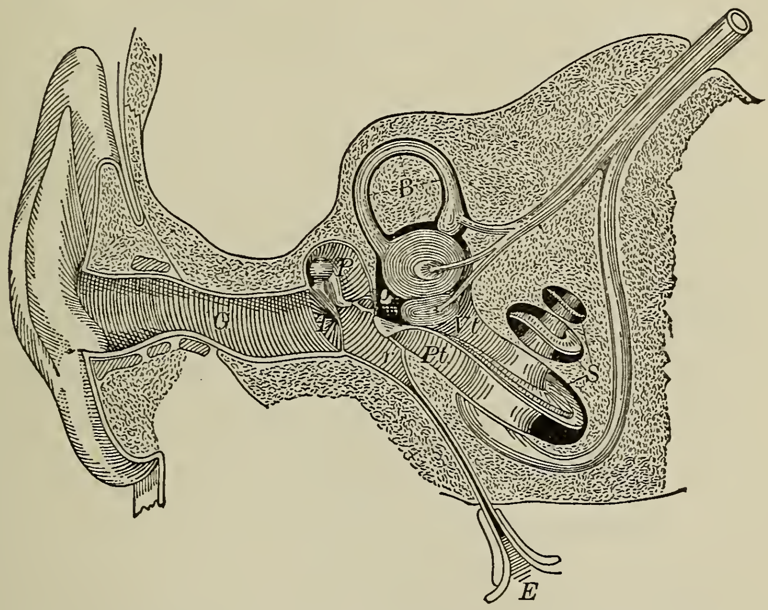



FIG. 47.—Semidiagrammatic section through the right ear (Czermak). *G*, external auditory canal; *T*, tympanic membrane; *P*, tympanic cavity; *o*, fenestra ovalis; *r*, fenestra rotunda; *B*, semicircular canal; *S*, cochlea; *Vt*, scala vestibuli; *Pt*, scala tympani; *E*, Eustachian tube.

(From Howell's "Text-Book of Physiology.")

*tympani* and *stapedius*)] simply furnish the means of transmitting air-vibrations from the outer world to the auditory nerves in the cochlea of the inner ear. The middle ear opens into the upper and back part of the mouth-cavity through the Eustachian tube, whose function it is to equalize the air-pressure on both sides of the tympanic membrane.

The outer shell or pinna of the ear receives the air-waves and conducts them inward through the external auditory canal. It is probable that the air-waves are modified somewhat by the structure of the outer ear, the shorter waves being strengthened and the longer waves lessened in amplitude. The ear-drum is a thin membrane, slightly funnel-shaped, with its apex turned inward. The three ear-bones, or ossicles, articulated together, stretch across the cavity of the middle ear from the ear-drum to the oval window of the inner ear, into which one of them—the stapes—fits. The two small muscles which attach to the ear-bones control, through the lever-like action of the bones, the tension of the ear-drum, thus adjusting it to a large range of tonal vibrations. It is supposed by some that air-vibrations are communicated from the ear-drum to the fluid—the perilymph—of the inner ear by means of the mechanical piston-like action of the ear-bones, which act in such a manner that the vibrations of the ear-drum are intensified at the oval window of the vestibule. But cases of persons whose ear-bones have been destroyed or removed by surgical operation, and who can, nevertheless, hear sufficiently well to carry on a conversation, prove that the vibrations may be carried across the middle ear-cavity without the aid of the ossicles. Vibrations may also reach the inner ear through the bones of the skull. If the ears are stopped, a feebly sounding tuning-fork cannot be heard; but if its base is pressed against the head, it can be heard distinctly. The ticking of a watch which cannot be heard with the ears stopped becomes audible when placed between the teeth.

The inner ear is composed of the bony labyrinth, an intricate chamber hollowed out of the temporal bone. Within the chamber lies the membranous labyrinth, a closed, irregularly shaped sac which fits very loosely to the walls of the bony chamber, and is separated from it by the *perilymph*, the fluid which fills the spaces outside the sac. The sac itself is filled with a fluid called the *endolymph*.

The vestibule is the central cavity of the bony labyrinth and opens out into the semicircular canals behind and into the cochlea in front. It communicates with the middle ear by means of the oval window (*fenestra ovalis*), into which the base of the stapes fits. From the lower part of the cochlea another opening (*fenestra rotunda*) closed by a thin membrane leads into the middle ear. The parts of the membranous labyrinth are the *utriculus*, which opens into the

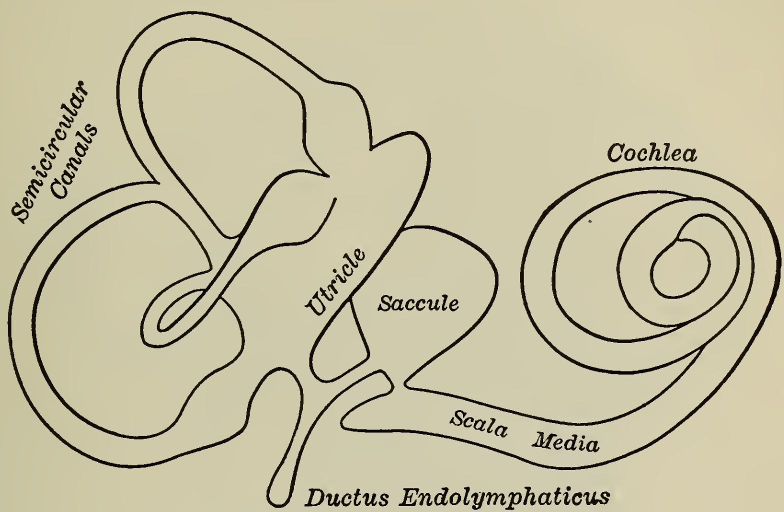



FIG. 48.—The membranous labyrinth (enlarged).

semicircular canals, the *sacculus* and its indirect connection with the utriculus, and the *membranous cochlea*.

The bony cochlea, a spiral canal which winds two and one-half times about its axis, or modiolus, contains three winding canals: the *scala vestibuli*, the *scala tympani*, and the *scala media*.

The *scala vestibuli* communicates with the perilymph in the vestibule and carries the vibrations set up there along its length to the apex of the cochlea, where it communicates through a small opening with the *scala tympani*, which descends to the base of the cochlea. Here the scala tympani ends at the round window. If the vibrations which have travelled the length of these tubes have not already spent their force, they are cushioned against the flexible membrane of the window. It is supposed that this acts as a safety device by lessening the force of the too powerful vibrations, which might injure the delicate specialized cell-structures of the inner ear. The *scala media*, or *canal of the cochlea*, lies between the scala vestibuli and the scala tympani, but does not communicate with them. On the floor of the scala media

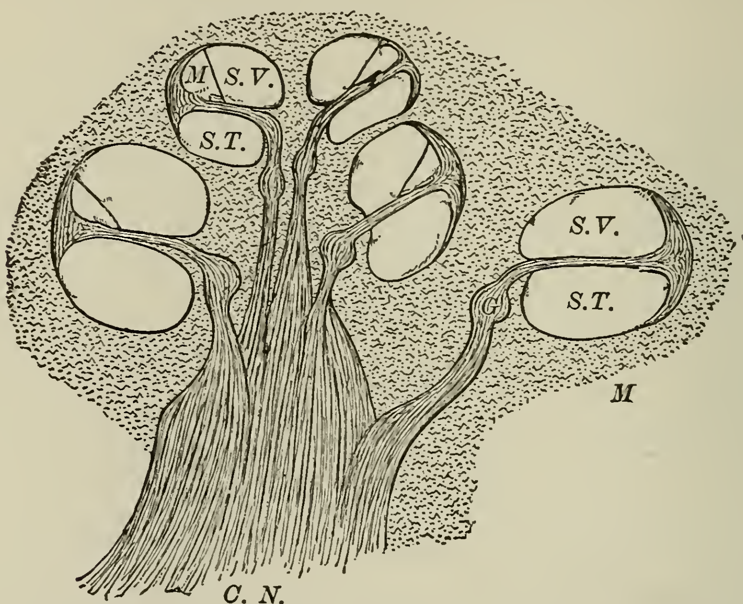



Fig. 49.—Longitudinal section of the cochlea. *S.V.*, scala vestibuli; *S.T.*, scala tympani; *M*, scala media; *G*, cochlear ganglion; *C.N.*, cochlear nerve.

are found the special organs of hearing: the *basilar membrane*, the *rods of Corti*, and the *hair-cells*. About these specialized cells, the fibres of the auditory nerve end. The canal of the bony cochlea is partly divided into upper and lower halves by a bony shelf. The basilar membrane stretches from the free edge of this shelf across to the outer wall of the cochlea and so makes the partition complete and at the same time forms the floor of the scala media, upon which the rods of Corti and the hair-cells rest. Another membrane (*membrane of Reissner*) stretches from the bony shelf to the upper wall of the canal forming the roof of the scala media and separating it from the scala vestibuli. (See Fig. 50.)

The *basilar membrane*, forming the floor of the spiral canal, is composed of short, transverse fibres, which reach from the shelf to the outer wall. Due to the fact that the spiral shelf becomes narrower as it ascends, the fibres of the basilar membrane become longer toward the apex of the cochlea. The number of basilar fibres is estimated at 24,000.

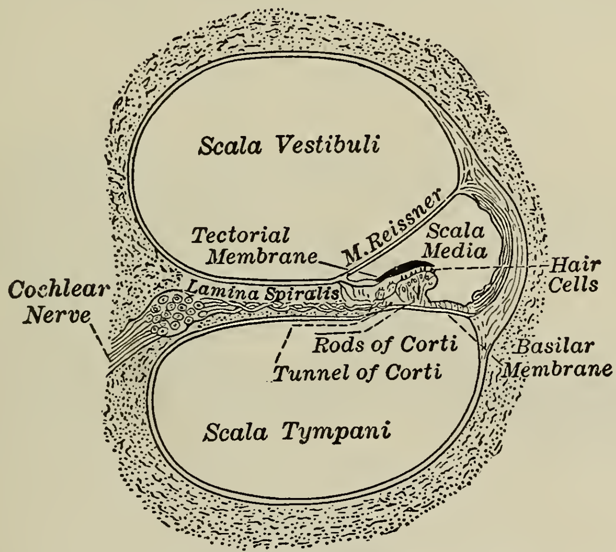



FIG. 50.—A transverse section of the cochlear tube.

The *rods of Corti* form two rows of rod-like cells, which stand upon the basilar membrane, and since the outer and inner rods lean toward each other and unite at their tops, they enclose a tunnel (*canal of Corti*) which extends the whole length of the cochlea. The rods of Corti are computed to be 9,500 in number.

The hair-cells lie on both sides of the rods of Corti. They consist of rows (one inner and four or five outer rows) of column-like cells which run parallel to the rods of Corti. The hair-cells bear short, stiff, hair-like processes upon their upper extremities.

The nerve-fibres of the cochlear branch of the eighth or auditory nerve pass through openings in the bony substance of the spiral lamina and, entering the scala media at the base of the hair-cells and rods of Corti, they terminate by arborization about these cells. In spite of the rather accurate knowledge we have of the structures in the canal of the cochlea, we are not able to determine which of these is directly responsible for the excitation of the nerve-endings. It is plain that vibrations set up in the fluid of the vestibule

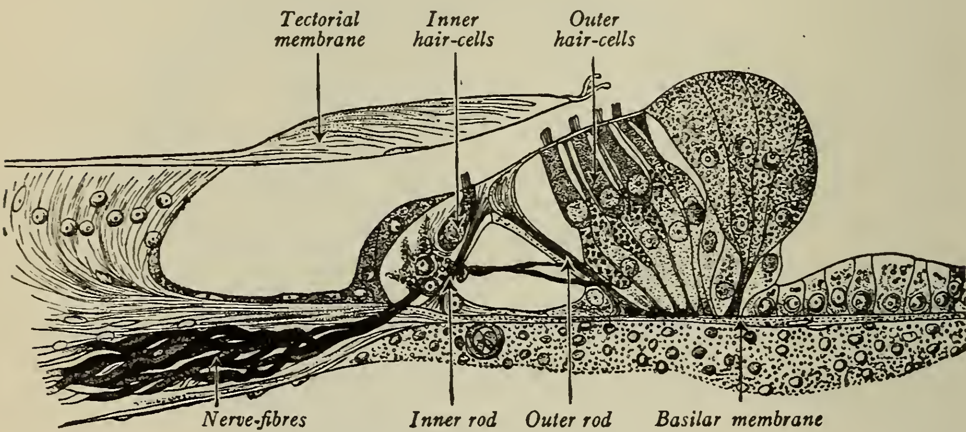



Fig. 51.—The organ of Corti.
(From Ladd and Woodworth, after Retzius.)

would, in passing up the scala vestibuli be communicated through the membrane of Reissner to the fluid in the scala media and set up vibrations of the basilar membrane and the hair-cells which rest upon it. What is needed, however, to explain the physiological basis of hearing is some apparatus which will act not as a whole but will respond in parts, or in different modes to different kinds of vibrations. The many different tonal qualities which the ear can detect call for a high degree of differentiation in the end-organs, in order that different nerve-impulses, corresponding to the different sensory qualities in consciousness, may be sent to the brain. The "sympathetic-resonance theory" of Helmholtz has been very widely held. He first suggested that the rods of Corti were responsible for our tonal discrimination, but he abandoned this theory because it was demonstrated that in birds the rods of Corti were lacking. Further, they were not numerous enough to account for the number of tonal qualities; and in addition they do not differ sufficiently in size and structure. He then accepted the suggestion of Hensen that the fibres of the basilar membrane, which differ in length, were capable of vibrating sympathetically with the different vibrations of the fluid of the ear. He found, therefore, in the basilar membrane a harp with its different strings tuned for different vibrations. The physics of this theory may be demonstrated very simply by lifting the dampers from the strings of a piano and singing a tone into them; the vibration of the voice will set in vibration sympathetically only that string which is tuned to the tone sung. So, thought Helmholtz, the different fibres vibrate sympathetically and selectively to the vibrations conveyed to it by the mechanism of the ear. There are some objections to the theory on the ground that the fibres of the basilar membrane are so extremely short and vary in length so slightly that they could not be thought of as resonators, or "vibrating strings." Moreover, if they do vibrate, the range of vibration would be too limited to account for the wide range of tonal differences. Recently Hardesty[1] has discovered that the fibres of the basilar membrane are bound together by cross-fibres in such a way that it seems improbable that they could vibrate individually.

Many other theories of audition have been proposed. The most noteworthy is the "telephone theory."[2] This theory holds that every rate of vibration sets up vibrations in the organ of Corti as a whole, affecting the adjacent hair-cells. The rate of vibration is transmitted to the nerve-cells and through them telephoned to the brain, where they are interpreted in terms of tonal sensations. According to this theory, the analysis of the stimulus takes place in the brain-cells, rather than in the end-organs, as is assumed in the Helmholtz theory.

[1] *American Journal of Anatomy*, 1908, VIII, p. 109.

[2] Rutherford: "The Sense of Hearing," *Lancet*, 1887, I, pp. 2–6.

**Brain Centres.**—The cortical centre for hearing is in the superior convolutions of the temporal lobes.[1] Complete deafness follows the destruction of both temporal lobes. In cases of lesion in one temporal lobe, partial deafness in the opposite ear follows. Sometimes when the lesion is not extensive or is located in neighboring areas, there is merely a disturbance of hearing, or a loss, not of the sensations of hearing, but of their associations, as in "word-deafness" (inability to understand spoken words). In this case the sounds are heard, but their meanings have been lost. In right-handed persons this occurs when the lesion is located in the left lobe. Since complete destruction of the auditory centre on one side does not cause complete deafness in the opposite ear, it would appear that not all of the fibres from one ear cross to the opposite side of the brain, but rather that each ear sends fibres to both sides of the brain. The path of the auditory impulses is roughly from the ear to the nuclei in the upper part of the medulla; from there by a second set of neurones they cross over to the opposite side of the medulla, thence by a third set of neurones to the internal geniculate and inferior quadrigeminum of the mid-brain, and from there by a fourth set of neurones to the temporal lobe. The pathways by which the two branches of the auditory nerve (the vestibular and cochlear) reach the brain are as distinct as their distribution in the ear, which is, of course, evidence for the difference in function of the two parts of the inner ear. The fibres of the vestibular branch pass from the semicircular canals to a nucleus (near the nuclei for the cochlear fibres) in the medulla, from there a second set of fibres crosses over to the opposite side of the medulla and go to the cerebellum.

**The Stimulus.**—Air-waves set up by vibrating bodies are the normal stimuli for auditory sensations. These air-waves may vary in length, in amplitude, and in form. The shorter the wave the quicker the rate of vibration. For instance,

[1] See Figure 28.

the short wires of the piano give a short wave-length and a very rapid rate of vibration per second, $c^3$'s vibration rate is 1,024 vibrations per second. On the other hand, the long wires give a longer wave-length and a slower rate of vibration per second; $C_0$'s vibration rate is 64 vibrations per second. The length of the air-wave (or the rate of vibration) determines the pitch of the sound. Variations in the amplitude of a given wave-length correspond to the variations in the intensity, or loudness, of the resulting sound. The form of the air-wave determines whether the resulting sound-sensation is simple or compound. The periodic simple harmonic waves give simple tones, while the periodic compound harmonic waves give compound or composite tones, or clangs, as they have sometimes been called.

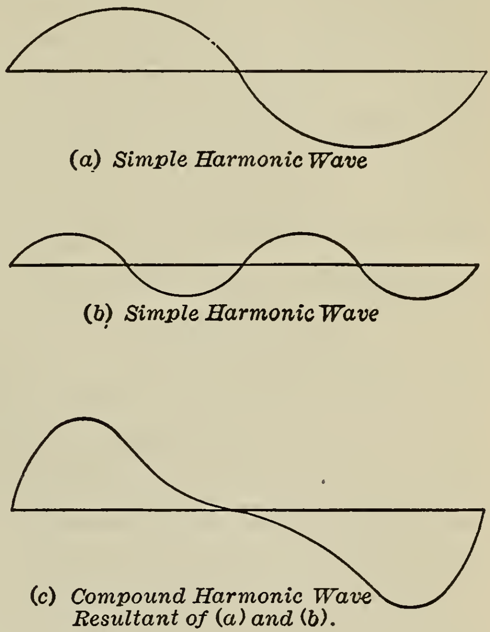



Fig. 52.—Both (*a*) and (*b*) represent simple harmonic waves of different lengths; (*b*) is one-half the wave-length of (*a*), but its rate of vibration is twice that of (*a*). These waves, when acting separately, produce simple tones which differ in pitch. When they act together the resultant wave is represented by (*c*) a compound harmonic wave, producing a compound tone, composed of the two tones corresponding to waves (*a*) and (*b*).

Most vibrating bodies give out compound waves. This is due to the fact that they are capable of vibrating not only as wholes, but also in parts. A string, for instance, vibrates not only in its entire length, but also in halves, thirds, fourths, etc., each part vibrating at the same time, but at different rates. The halves execute twice as many vibrations as the whole string, the thirds three times, and the fourths four times as many. All these vibrations produce a resultant air-wave of the compound type, which form of stimulus arouses a compound tone. A compound wave may therefore be treated as a composite of simple waves, and the resulting compound tone as a complex of pure tones. Periodic waves (simple or compound) are so termed because they repeat the same movements, while non-periodic are irregular.

The normal manner for sound-vibrations to reach the inner ear is through the external ear, tympanic membrane and ossicles of the middle ear to the fluid of the vestibule. But we have already mentioned the fact that sound-stimuli may reach the inner ear by conduction through the bones of the skull. It is practically impossible to excite the end-organs of one ear without at the same time affecting those in the other ear; for even if one ear is completely stopped, the stimulus may be conducted to it through the skull-bones or through the Eustachian tubes.

**Noises.**—The difference in the mental qualities of noises and tones seems to be so great that it has been suggested that they must arise from different end-organs. Accordingly, attempts have been made to find other structures than those in the cochlea to which noise could be attributed. The saccule of the vestibule was supposed to be that structure. If, however, noises and tones have their origin in different end-organs, it is very probable that there would be pathological cases reported in which ability to hear noises would exist together with tonal deafness, or that noises would be lost and tones retained. But no such cases have been reported. Careful observation reveals a closer relationship between noises and tones than might be supposed. Certain noises reveal tonal qualities. The hum of street noises, the drone of the waves, the buzz of many voices, or even the pop of a pistol possess slight tonal qualities. On the other hand, many closely related tones, if sounded at the same time, produce a noise. Strike a dozen or more adjacent keys of the piano simultaneously and note the effect. A single instantaneous exposure of a vibrating tuning-fork may be heard not as a tone but, if the exposure is short enough, as a noise.

Noises may be divided into two classes: (1) the *momentary* or *explosive noises*, and (2) the *continuous noises*. Of the first class we have such noises as are represented by the words "crackle," "crack," "snap," "pop." Of the second class we have the hissing, roaring, rumbling sounds.[1] No success has met the efforts to further analyze these complex noise experiences into their elementary sensory qualities. How many simple noise qualities there are has not been determined.

If we accept the Helmholtz theory that simple tones are the result of the vibration of single fibres in the basilar membrane, we might further assume that noise arises when a large number of adjacent basilar fibres are set simultaneously vibrating, *i. e.*, while simple tones come from the stimulation of single fibres (or a series of properly related fibres), noises result from the stimulation of the basilar membrane as a whole, or in large sections or blocks.

**Tones.**—Tones constitute a continuous series of constantly changing sensory qualities from the lowest noticeable pitch to the highest. The change in pitch corresponds to the change in the vibration rate of the stimulus. The lowest tone that can be heard varies somewhat in different individuals, but lies between 20 and 28 vibrations per second, while the highest tone corresponds to vibration rates of from 22,000 to 43,000 vibrations. Some investigators report individuals who can detect tones from vibration rates as high as 50,000. The average, however, is about 32,000 vibrations. The extreme limits of tonal hearing may safely be put at 16 vibrations for the lowest tone and 50,000 vibrations for the highest tone.[2] In old age, the end-organs for

[1] Titchener: "Text-Book of Psychology," p. 95.

[2] The upper limit of tonal hearing may be determined by the Galton whistle, an instrument found in any psychological laboratory. The lower limit is determined by means of large tuning-forks.

tone become less responsive, restricting the range of tonal qualities both at the higher and lower limits. Between the highest and lowest tone, there are for the human ear over 11,000 discriminable tones. The ordinary musical scale, however, makes use of only about 100 tones lying at the lower part of the series; 88 of these tones and half-tones are represented on the keyboard of the grand piano, from $A_2$—26.6, to $c^5$—4,096 vibrations.

The ability to detect differences in pitch is not the same for all parts of the scale, but in its middle part—from $c^1$ to $c^2$ (256 to 512 vibrations)—the average, unpractised ear can sense a difference in pitch corresponding to a difference in the stimulus from 8 to 16 vibrations. This may be reduced by practice. Trained musicians have detected a difference of one-third of a vibration. Some individuals are extremely insensitive to differences of pitch. Cases have been reported where a difference of 64 vibrations (two whole tones on the musical scale) cannot be distinguished. The ability to distinguish differences in tones must not be confused with the ability to "sing in tune." A singer who is able to detect a difference of one-half vibration may not be able to control the pitch of his voice within the limits of 8 vibrations or a quarter of a tone.

When different notes are struck on a musical instrument, we usually determine the pitch of each note relatively, by referring the given tone to a standard tone whose place in the scale we already know. Given this standard, we can name any other tone by reference to the standard. There are some few individuals, however, who seem to possess what is known as "*absolute pitch.*" They are able to judge *absolute tone*, which is quite different from determining differences in the pitch of two tones or in judging the interval between them. In absolute pitch there must be a very close and definite association between the tonal quality and the name of the tone, which is not present in the majority of musicians.

A certain form of tone-deafness may produce what are known as *tonal gaps* and *tonal islands*. These cases may appear when the outer and middle ears are perfectly normal, thus indicating the absence of certain specialized end-organs for tone. It may happen that although the range of tonal qualities is as great as usual, certain groups of tones cannot be heard, making a gap in the otherwise normal tonal series. Or, in other cases, only a few of the tones may be heard, while those above and below this group are absent, making a "tonal island." Such phenomena furnish further evidence of distinct end-organs for different tones.

**Compound Tones.**—Only a few specially constructed instruments are capable of producing simple tones, or at least tones that approximate simple tones. The tuning-fork is one of these. It produces a simple pendular wave and consequently a simple tone. Nearly all resounding bodies, even the vocal cords, give non-pendular or complex waves and arouse complex tones. When a single note is sounded by the voice, piano, violin, etc., what appears to the untrained ear as a single tone can, by careful observation, be analyzed into several simple tones, called *partial tones*, sounding simultaneously. The lowest partial—the most dominant or intense tone—is the *fundamental tone*, and the others are the *upper partials*, sometimes called *overtones*. These upper partials are caused by the fact, already mentioned in the discussion of sound-stimuli, that resonant bodies vibrate in parts as well as in wholes. The fundamental arises from the vibration of the whole body, while the upper partials arise from the vibrations of its respective parts. If, for instance, the wire of a "sonometer" (a long wire stretched on a resounding box) is struck with the sound hammer, it will vibrate as a whole, in halves, in thirds, in fourths, etc. Each part will give out its own simple tone, so that the tone that is heard is compound, made up of the fundamental tone (from the whole wire), the second partial (from the half wire), the third partial (from the third of the wire), the fourth partial (from the fourth of the wire). Other partials may be present, but they are very faint. The intensity of the partials wanes as the parts of the wire from which they arise become shorter. However, these four simple tones, the fundamental and the three other partials mentioned, can be easily analyzed out of the compound tone.[1] The untrained ear may have some difficulty at first in hearing all the partials mentioned, but a little practice will enable one to detect them. It should be noticed that the upper partials or overtones are always higher than the fundamental, and that they correspond to vibration rates which are simple multiples of the vibration rate of the fundamental. Thus, if the whole wire has a rate of 256 vibrations, the second partial is 512 vs., twice the rate of the fundamental; the third partial is 768 vs., three times the fundamental; the fourth partial is 1,024 vs., four times the fundamental.

**Timbre.**—The character of compound tones, which is known as *timbre*, is due to the presence in them of the partial tones or overtones which we have just discussed. It is evident that a given tone of the same pitch and intensity sounds differently on different musical instruments. We can easily tell the difference between the same note on a piano and on a violin. This difference is due to the difference in timbre, and timbre is determined by the number and the intensity of the overtones present in the tones. The tones of different instruments vary in this respect. The flute has few and weak overtones. This gives its tone a dull character. In brass instruments the higher overtones predominate, giving a piercing quality to their tones. And so we find great variety in the character of the overtones in various musical instruments. Some may have the odd-numbered overtones and

[1] A simple way to isolate the partial tones is as follows: To isolate the second partial, strike the wire at one-fourth its distance from one end to the other, then damp exactly in the middle by touching lightly with a piece of cotton; third partial, strike at one-sixth and damp at one-third; fourth partial, strike at one-eighth and damp at one-fourth.

some may have the even-numbered overtones; some may possess intense lower, others intense higher overtones. Of course, the noises which accompany the production of tones, like the plucking sound of the banjo or the scraping of the violin, may also aid one in detecting the difference in tones of different instruments, and have been considered by some authorities as contributing to differences in timbre.

**Beats.**—If two $c^1$ tuning forks, each of 256 vs., are set vibrating at the same time, the two tones will fuse together, giving a perfectly smooth, uniform tone. If, now, one of the forks is weighted with a bit of plastic clay or chewing-gum, its vibration frequency will be lessened and, consequently, its pitch slightly lowered. The two forks will, however, give a single tone, but the intensity of the tone will rise and fall regularly. The points where the tone wanes in intensity are called *beats*. They are due to the interference of the sound-waves of the two tones. The waves of the slower fork lag behind the waves of the other fork more and more until a point is reached where the crest of the one and the trough of the other coincide. The waves then interfere or oppose each other and momentarily diminish the intensity of the combined tone. It is plain that the number of beats in a second will be equal to the difference between the vibration frequencies of the two forks. If the weighted fork is reduced to 255 vs., while the other remains at 256, there will be exactly one beat per second. By gradually increasing the weight upon the fork, the number of beats per second will be increased. As the beats become more rapid, the character of the tone changes. With 2 or 3 beats a second the tone rises and falls gradually, at 8 per second the beats begin to strike more vigorously, while further increase up to 16 gives a rattling character to the tone. At 28 per second the tone is rough, harsh, and discordant; the maximum dissonance between the tones is reached at about this point. When the number of beats reach about 50 per second for this part of the scale, the dissonance disappears and the two tones flow together smoothly again and manifest no disturbance.

Careful observation shows that when the pitch of the lower tone becomes sufficiently different (about 8 vs.) from the other tone to be distinguished from it, an "*intertone*" appears, lying midway between the two generating tones. It is this tone which carries the beat. When the interval between the two generating tones reaches 40 vibrations, the *intertone* becomes inaudible and the two generating tones emerge and become distinguishable.

Beats may be heard even when the tones are completely separated and conducted separately through sound-tight tubes, one to each ear. Since the sound-waves in this case are led to different end-organs, it was supposed by some that beats are of central origin, *i. e.*, that they are produced in the cortical centres and not in the end-organs. But this theory is discredited by the fact that sound-waves in each ear can pass by bone conduction to the opposite ear. On account of this it is not possible to separate the two tones so far as the ears are concerned.

**Combination Tones.**—If two tones that are not too similar in pitch are sounded together, there may be heard a third tone, much lower, sounding with them; and if the observation is keen enough, a faint fourth tone may be heard, much higher than the two original tones. The lower extra tone is called a *difference tone*, and the higher extra tone a *summation tone*. Both are known as *combination tones*. The difference tone has a vibration rate equal to the difference in rate between the original tones, and the summation tone has a rate equal to the sum of the rates of the two original tones. If, for instance, we sound the tones $d^4$ (2,304 vs.) and $g^3$ (1,536 vs.), the difference tone will be $g^2$ (768 vs.), and the summation tone will be $b^4$ (3,840 vs.).* The summation tone

*The higher tones are preferable for demonstrating combination tones. Quincke's tubes $d^4$ and $g^3$, when sounded together, bring out these tones fairly well.

is very weak. Besides the difference tone mentioned, a second, third, and even a fourth difference tone has been detected. The cause of these combination tones is supposed to originate in the ear itself—either in the tympanic membrane or in the membrane covering the round window. It has been demonstrated that when thin membranes are acted upon simultaneously by two sound-waves whose frequencies hold a certain relation to each other, other waves are propagated by the membranes. It seems necessary to explain combination tones in this way, for they have been demonstrated when no external air-vibrations corresponding to them were present. For this reason they have been called *head-tones*, because the vibrations causing them are generated within the head.

**Intensity.**—The intensity of a sound-stimulus depends upon the amplitude of the sound-waves, and the intensity of the sensation increases with the intensity of the stimulus. The relation between the intensity of the stimulus and the intensity of the sensation was discussed under Weber's Law (see page 101). Before a sound-stimulus can arouse a sensation it must reach a certain degree of energy. In order to determine accurately the minimal or just-observable sound-stimulus, tests must be made in a sound-proof room, in order to eliminate all distracting sounds. There are, however, some individuals who can hear more distinctly when they are surrounded by a medley of sounds, such as the sounds of a noisy street, or shop, or in a room where a buzz of conversation is going on. Such individuals possess a blunted sensitivity to sound. It requires rather intense sound-stimuli to overcome the inertia of a sluggish auditory apparatus (in some cases, the ossicles of the middle ear). After the apparatus is once limbered up, it becomes more sensitive to sound-stimuli.

**Extensity.**—In the case of cutaneous sensations, one and the same stimulus may act upon like end-organs, situated at different points on the skin. In this case it arouses the same quality of sensation, which, however, may vary in space character. In hearing, however, this is probably not true. Here a single stimulus acts only upon a single auditory fibre, or the same band of fibres (Helmholtz theory). If this is true, a given tone-sensation cannot vary in extensity. The extensity of a given tone and its quality would never, for this reason, be separated in sensory experience. Tones do not, therefore, possess spatial arrangement or "alongsideness" among themselves. But they may possess extensity in the sense that we have used the word on a preceding page. The low bass tones seem bigger—more massive—than the high tones of the treble. It has been suggested that the differences in pitch are in themselves differences in extensity. This would apparently call for another theory for the physiological basis of hearing. In such a theory high tones would correspond to the stimulation of only a few cells or fibres, while the low or more massive tones would correspond to the stimulation of a larger number.

**Musical Tones, Consonance, and Dissonance.**—If we compare the different tones in any tonal series, we shall find that those that are at certain intervals apart are psychologically more alike than others, *i. e.*, that some pairs of tones fuse or blend much more completely than do other pairs. On the other hand, some tones stand alone and refuse to unite. The selection of tones for æsthetic purposes (music) was determined by this likeness and difference in the sensory character of tones. The musical scale is based primarily upon the fact that any tone whose vibration rate is double that of another will fuse readily with it, producing the maximum degree of consonance, or union. This determines the octave. The keyboard of the grand piano has seven and a fraction octaves, ranging from $A_2$ (26⅔ vs.) to $c^5$ (4,096 vs.).[1]

[1] These are the vibration frequencies adopted for scientific purposes. The German scale would read $A_2$, equals 27½ vs. to $c^5$, equals 4,224 vs. In this scale. middle c ($c^1$) equals 264 vs. On the English piano, middle c is 270 vs. While the absolute vibration frequencies may differ on different scales, the tonal intervals or tonal relations are always the same.

The octaves are as follows:

| | | | | | |
|---|---|---|---|---|---|
| Subcontra octave | .......... $C_2$ = | 16 vs. to $C_1$ = | 32 vs. |
| Contra " | .......... $C_1$ = | 32 vs. to $C_0$ = | 64 vs. |
| Great " | .......... $C_0$ = | 64 vs. to $c^0$ = | 128 vs. |
| Small " | .......... $c^0$ = | 128 vs. to $c^1$ = | 256 vs. |
| Once accented " | .......... $c^1$ = | 256 vs. to $c^2$ = | 512 vs. |
| Twice " " | .......... $c^2$ = | 512 vs. to $c^3$ = | 1,024 vs. |
| Thrice " " | .......... $c^3$ = | 1,024 vs. to $c^4$ = | 2,048 vs. |
| Four times " " | .......... $c^4$ = | 2,048 vs. to $c^5$ = | 4,096 vs. |

To illustrate the tonal intervals within the octave, we may select the once-accented octave $c^1$ (middle c)–$c^2$. The whole tones (diatonic scale) within the octave are:

$c^1$ = 256 vs.
$d^1$ = 288 vs.
$e^1$ = 320 vs.
$f^1$ = 341.3 vs.
$g^1$ = 384 vs.
$a^1$ = 426.6 vs.
$b^1$ = 480 vs.
$c^2$ = 512 vs.

The intervals separating the successive notes of this scale may be expressed by the ratio of their vibration frequencies. The interval of $c^1$ and $d^1$ = 8 : 9; $d^1$ and $e^1$ = 9 : 10; $e^1$ and $f^1$ = 15 : 16; $f^1$ and $g^1$ = 8 : 9; $g^1$ and $a^1$ = 9 : 10; $a^1$ and $b^1$ = 8 : 9; $b^1$ and $c^2$ = 15 : 16. The interval of $c^1$ and $g^1$ = 2 : 3 ($c^1$ = 256 vs., $g^1$ = 384 vs.; 256 : 384 = 2 : 3). As has been said, the most perfect consonance of all the possible intervals is that of $c^1$ and $c^2$ = 1 : 2. Within the octave, other intervals may be selected, giving decreasing degrees of consonance, some intervals producing a decided dissonance. If we arrange the intervals in their order of consonance or tonal likeness, starting with $c^1$, we have:

$c^1$ and $c^2$ = 1 : 2 (octave).
$c^1$ and $g^1$ = 2 : 3 (fifth).
$c^1$ and $f^1$ = 3 : 4 (fourth).
$c^1$ and $e^1$ = 4 : 5 (major third).
$c^1$ and $a^1$ = 3 : 5 (major sixth).

These are the pleasing or consonant intervals within the octave. On the other hand, the interval of $c^1$ and $d^1$ = 8 : 9, major second; and $c^1$ and $b^1$ = 8 : 15, major seventh, are decidedly dissonant and displeasing. In the simple diatonic scale any two tones whose vibration frequencies stand to each other as 1 : 2 (octave), 2 : 3 (fifth), 3 : 4 (fourth), 4 : 5 (major third), or 3 : 5 (major sixth) will, when sounded together, blend without roughness or dissonance. If, however, we should start with any other tone (tonic), say $d^1$, and calculate the vibration frequencies of the tones that lie a fifth, a fourth, a major third, a major sixth, etc., above $d^1$, there would not be a sufficient number of tones in the diatonic scale to construct these intervals. So it was necessary, in order to maintain these relations between the tones, to insert other tones within the octave. But such a large number of new tones is required to make the intervals exact that it makes the octave unwieldy. In overcoming this difficulty, a compromise was made by inserting five half-tones for the pianoforte and other similarly tuned instruments, so that the octave contains twelve tones, equally distant from each other. This is the *equally tempered scale*, which is now in use in this country and Europe. The only exactly tuned interval in the equally tempered scale is the octave; all the others are slightly out of tune. The approximation to the true intervals is so close, however, that for all but the most sensitive and highly trained ears the result is satisfactory.

*Consonance* and *dissonance* have been explained in several ways. According to Stumpf,[1] consonance is due to the fusion of tones. Those tones that blend smoothly and fuse with one another more or less completely, so that the resulting sensory experience resembles a single tone sensation, are consonant; while those tones that refuse to blend or fuse together into a single experience and remain apart, are dissonant. Unity of tonal impression is, therefore, according to Stumpf,

[1] "Konsonanz und Dissonanz," *Beiträge zur Akustik und Musikwissenschaft*, 1898, I, 1.

the measure of consonance: Helmholtz considers consonance the absence, and dissonance the presence of beats in simultaneously sounding tones. In considering this theory, we must remember that most single tones are compounds, made up of fundamentals and overtones. The overtones of one note may coincide or may beat with the overtones of another note. The degree of consonance of tones goes hand in hand with the amount of coincidence of their overtones. In the octave, where there is perfect consonance, the overtones coincide and, therefore, there is no beating. In the minor sixth (c – ♭a = 5 : 8), just on the border-line between consonance and dissonance, the lower overtones (the second of c and the first of ♭a) beat audibly with each other. In more dissonant intervals the overtones beat still more markedly. The roughness of dissonant intervals, produced by the beats, is unpleasant, just as intermittent sensations of any kind are unpleasant.

In regard to successive tones, Helmholtz has suggested that their relation depends upon the similarity or dissimilarity of their overtones. A tone is most like its octave tone because the overtones of the two are coincident. In passing from the one to the other a large part of the end-organs active for the first tone are stimulated again by the second. A tone and its second or its seventh show little, or no, kinship, because the overtones of the one are different from those of the other. In passing from the one to the other of such tones, different end-organs are stimulated. Therefore the tones have nothing in common.

# CHAPTER VIII

## VISUAL SENSATIONS

The eye furnishes us by far the greatest number and variety of sensory experiences of all the sense-organs. The sensitive end-organs which give these visual sensations are the rods and cones of the retina. The eyeball with all its parts acts as a camera obscura to bring the rays of light from outer objects to a focus upon the sensitive end-organs. It has three coverings: (1) The *sclera*, an outer protective coat, extending into and forming the transparent cornea in front; (2) the *choroid*, the color coat, whose dark pigment excludes all the light from the inner chamber, except that which enters through the pupil, a round adjustable opening in the choroid; and (3) the *retina*, the thin inner lining of the eyeball, containing the sensitive rods and cones connected with the fibres of the optic nerve, which are distributed here for the purpose of transmitting impulses to the brain. The refractive media of the eye are: (1) The *cornea*, the transparent covering in front; (2) the *aqueous humor*, a lymph-like fluid filling the anterior chamber of the eyeball; (3) the *crystalline lens*, a clear, transparent body, biconvex in shape, enclosed in a thin, elastic capsule and attached to the suspensory ligament; and (4) the *vitreous humor*, a jelly-like body filling the back part of the eyeball. These media are sufficient when the eye is at rest to bring the parallel rays from objects more than 20 to 30 feet distant to a focus on the retina. For nearer objects the crystalline lens changes its curvature to suit the distance, becoming more and more convex as objects approach and less convex as objects recede from the eye. This adjustment of the lens for near and far objects is termed *accommodation*.

Accommodation for near objects is brought about by the action of the ciliary muscle, which by contracting lessens the strain of the suspensory ligament on the lens and allows it

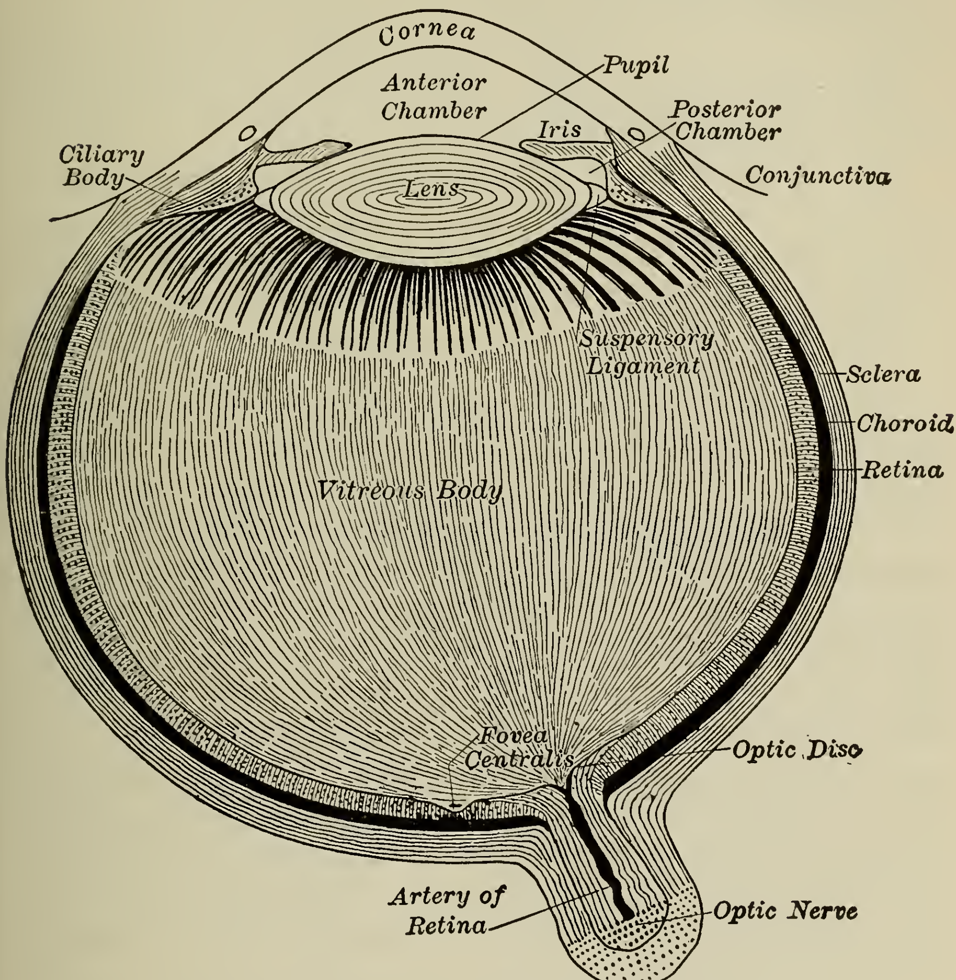



FIG. 53.—Horizontal section through the left eye.

by its own elasticity to become more convex. For far objects the ciliary muscle relaxes, allowing the eyeball to bulge outward, and so by pulling on the suspensory ligament flattens the lens.

By means of six muscles attached to the external coat of the eyeball the eyes are revolved in their sockets so that they may be directed in different directions. For far objects the lines of sight for the two eyes are practically parallel, but for near objects they converge. In looking from a near object to one farther away, the lines of sight diverge, *i. e.*, become less convergent. These acts of adjustment are known as *convergence* and *divergence*. The acts of convergence, divergence, and accommodation take place reflexly.

**The Retina.**—The thin, transparent retina extends forward almost to the ciliary process, so that it covers all the inner surface of the eyeball, upon which images of objects can fall. There are many different layers or differentiated structures in the retina, which the microscope is able to reveal. Of these the rods and cones are of most interest to us because they are the end-organs which receive the light-stimuli and generate the nervous impulses which are sent to the brain centres, resulting in sensations of light and color. The rods and cones are turned away from the source of light, making it necessary for the light-rays to penetrate all the layers of the retina before falling upon them. Under certain conditions the shadows cast by the blood-vessels in the inner layer of the retina can be seen, showing that the part of the retina which receives impressions lies on the side of the retina away from the source of light and back of the retinal blood-vessels. If, in a dimly lighted room, a candle is held close but to one side of the eye, and if while one is peering into the darkness the candle is moved slightly but rapidly to and fro, a network of dark branching lines will be seen. This is known as *Purkinje's network*.

In the centre of each retina, directly opposite the pupil, there is a small *yellow spot* (*macula lutea*), within which is found a pit-like depression called the *fovea centralis*. Here the cones are directly exposed to light-rays because the inner layers and blood-vessels are pushed aside to form the pit of the fovea. It is upon the fovea that the images of objects are focussed in direct vision. The fovea is the most sensitive part of the retina, and therefore gives the most distinct vision. In looking at an object we reflexly turn the eyes so that its light-rays fall upon the fovea.

The distribution of the rods and cones in the retina is not uniform. There are no rods in the fovea centralis. Only cones are found there. They decrease in number, however, as we pass toward the periphery of the retina, where the rods greatly predominate. Movement of objects is sensed more quickly by the outer parts of the retina, while accurate vision is best at the fovea. The fact that the periphery of the eye is most sensitive to movement probably has a biological significance. Sensitiveness to the approach of danger from behind or from the sides gave organisms a great advantage in their ability to survive. Man has evidently shared in this sensitiveness to movement in indirect vision. The periphery of the retina is less sensitive to color; in fact, the extreme outer portion is color-blind.

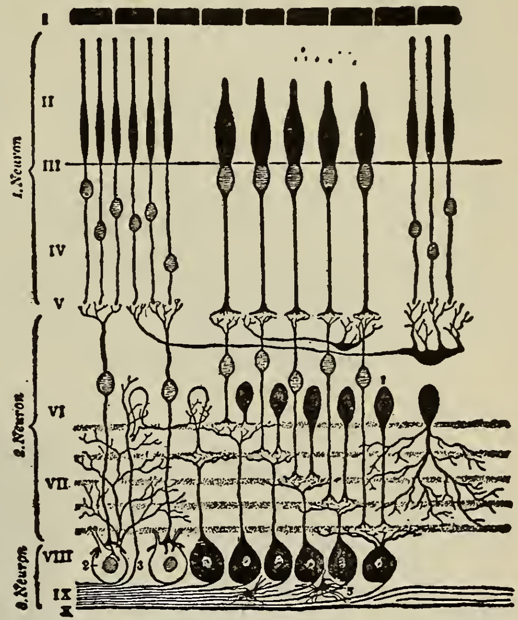



FIG. 54.—Diagrammatic section of the retina. (After Greeff). I, Pigment epithelium; II, rods and cones. Outside the fovea the rods and cones are both found, in the fovea only cones. III, IV, V, VI, VII, show intermediate neurones and nerve connections. From the neurones at VIII the optic fibres pass out as indicated at IX toward the optic disc where they leave the eyeball to form the optic nerve; X limiting membrane of retina. A ray of light entering the eye passes through the retina from X to II.

The optic nerve enters each eyeball on the nasal side of and at a point not far from the fovea centralis. At its point of entry, known as the *optic disc*, there are no rods and cones; consequently, no vision is possible there. For that reason the optic disc is commonly known as the blind spot.

FIG. 55.—Close the left eye. Fixate the cross in the figure. When the book is a little over eight inches from the eye, the dot will disappear. Slowly move the book farther away until the square disappears. The eye must be steadily fixed upon the cross. The explanation of the inability to see the figures is, of course, found in the fact that they fall upon the blind spot.

(From Thorndike's "Elements of Psychology.")

FIG. 56.—Notice that when the white disc in the black square falls upon the blind spot it is filled in with the black of its surrounding background. In order to project the disc upon the blind spot, close the left eye and fixate the cross with the right eye. The book should be held about eight inches from the eyes with the cross directly in front of the right eye.

(From Thorndike's "Elements of Psychology.")

The iris of the eye functions in the same way as the diaphragm of a camera. By contracting and expanding it varies the size of the pupil, thus controlling the amount of light entering the eye. If too much light enters, the pupil becomes smaller; if not enough, it becomes larger. This action of the iris is a pure physiological reflex, known as the pupillary reflex. It is set off by the action of light upon the eye.

The power of the resting eye, as an optical instrument, is such that parallel rays (rays from distant objects) are brought to a focus upon the retina. In order to form clear images of nearer objects whose rays are divergent, the curvature of the lens must be changed by the act of accommoda-


FIG. 57.—The change of the lens in accommodation. (From Ladd and Woodworth, after Helmholtz.) The left half of the figure shows the lens focussed on a distant object, the right half on a very near object. *c*, the ciliary muscle; *s*, the suspensory ligament.

tion. In this case the front surface of the lens bulges forward, making the lens more convex, thus increasing its focal power. This is illustrated in the accompanying cut.

The limits of accommodation vary with the condition of the eyes and with age. The young, elastic lens can accommodate for a distance of about 7 to 10 cm. In *presbyopia*, inelasticity of the lens attendant upon old age, the near limit of accommodation may be increased to 50 or 60 cm. This limit may be determined very roughly by closing one eye and holding up a pin before the other eye, and after getting a clear image moving it toward the eye until the image begins to blur. The lens is not able to bring the light-rays to a sharp focus upon the retina nearer than this point.

If the eyeball, from the retina to the lens, is too long, or if the refractive surfaces of the lens or cornea[1] are too great

[1] The cornea also acts as a refractive medium.

in curvature, the rays from distant objects are brought to a focus in front of the retina and are diverging when they reach it, blurring the image. Only near objects can be seen clearly. This condition is called *myopia*, or *near-sightedness*. Concave glasses will correct the difficulty. If, on the other hand, the eyeball is too short, or the curvature of the lens and cornea is not great enough, light-rays are brought to a focus back of the retina. This is called *hyperopia*, or *far-sightedness*. By wearing convex glasses the light-rays are brought to a focus at the retina. Another condition, known as *astigmatism*, is caused when the refractive surfaces (usually the cornea) are not perfectly curved. When this is the case the rays from one part of an object may be properly formed on the retina, while other rays are not, resulting in a badly focussed image and constant eye-strain.

The image of an object upon the retina is upside down. The fact that we see the object right side up, although its retinal image is upside down, offers no difficulty when we consider that we are not conscious of the retinal image itself. The spatial relations of up and down, right and left, are a matter of association entirely. We perceive as "up" that part of an object to which the hand must be raised in touching or grasping it.

**The Optic Nerve and Optic Centres.**—The nerve-fibres from all parts of the retina are brought together at the optic disc and there leave the eyeball as the optic nerve. The nerves, one from each eye, pass backward and, joining together, form the *optic chiasma*, or *optic commissure*. Here each nerve divides, one half going to the right brain and the other going to the left brain. Part of the fibres from each retina, those from the outer or temporal halves, pass to the same sides of the brain, while the other fibres, those from the inner or nasal halves of the retinæ, cross over in the chiasma and pass to the opposite sides of the brain. According to this arrangement, the fibres from the temporal half of the right eye and the nasal half of the left eye go to the right

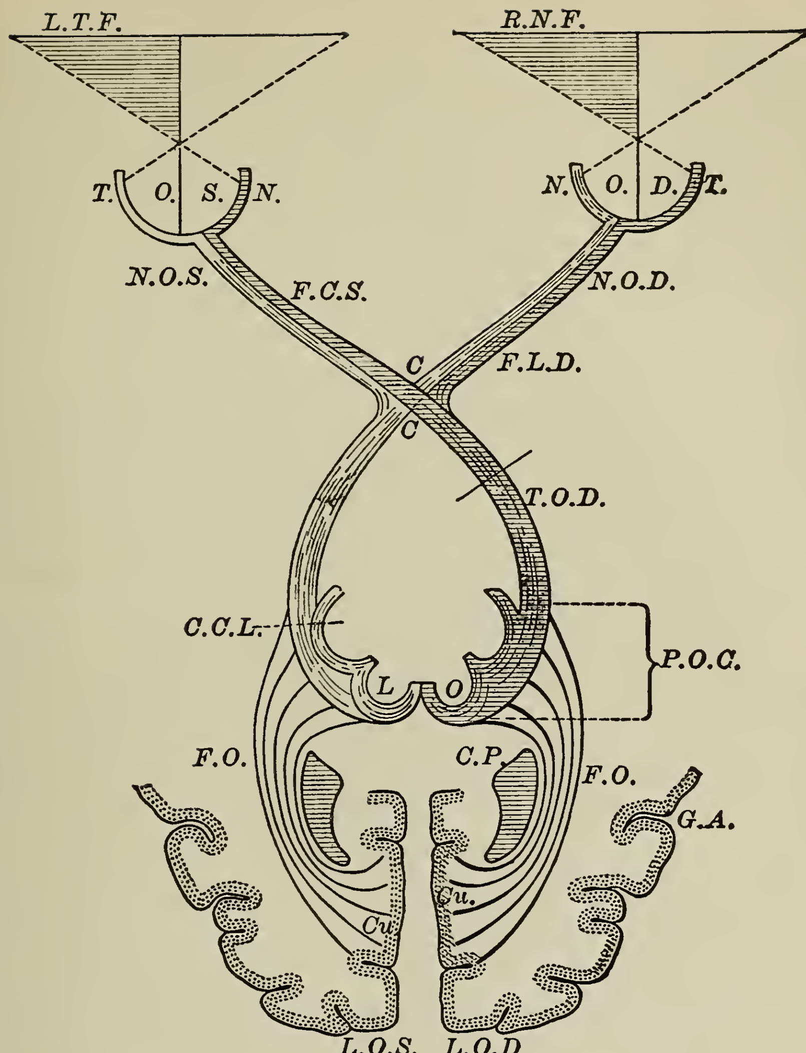



Fig. 58.—Scheme of the mechanism of vision. (James after Seguin.) The cuneus convolution (*Cu.*) of the right occipital lobe is supposed to be injured, and all the parts which lead to it are darkly shaded to show that they fail to exert their function. *F.O.* are the intra-hemispheric optical fibres. *P.O.C.* is the region of the lower optic centres (corpora geniculata and quadrigemina). *T.O.D.* is the right optic tract; *C*, the chiasma; *F.L.D.* are the fibres going to the lateral or temporal half *T.* of the right retina, and *F.C.S.* are those going to the central or nasal half of the left retina. *O.D.* is the right, and *O.S.* the left, eyeball. The rightward half of each is therefore blind; in other words, the right nasal field, *R.N.F.*, and the left temporal field, *L.T.F.*, have become invisible to the subject with the lesion at *Cu.*

(From Angell's "Psychology.")

brain, while the fibres from the temporal half of the left eye and the nasal half of the right eye go to the left brain. Accordingly, light-stimuli from objects on the left side of the body (falling upon the right half of each retina) send their impressions to the right brain, while impressions from objects on the right side of the body go to the left brain. After leaving the optic chiasma the nerve-fibres go to the mid-brain, where they terminate in the optic thalami, external geniculate bodies and the superior quadrigemina. There they make connections with another set of fibres, which pass to the cuneus convolutions of the occipital lobes, which constitute the cortical centres for vision. The right occipital cortex contains, then, the centre for the right halves of the retinæ, while the left occipital lobes contain the centre for the left halves of the retinæ.

If one of the optic nerves should be cut, complete blindness of the corresponding eye would result. But if one of the optic tracts should be cut it would cause blindness in one half of each eye, or *hemianopsia*, as it is called. A lesion in one of the occipital lobes may also cause hemianopsia.

From this brief description of the eye and its connections with the brain, we see that it is a wonderfully arranged photographic instrument whose many parts all conspire to the one end of producing a clear image of outer objects upon the sensitive retina. It is very evident that the image itself is not sent to the brain. Some physiological process in the end-organs must intervene between the image and the impulses which go to the cortical centres. Just what that process is, is a matter of conjecture, as we shall see when we take up the color theories. It has long been supposed that it is chemical in nature. So, when it was discovered that the outer ends of the rods became strongly tinged with a purple substance when light was excluded from the eye, and that this substance, known as *visual purple*, bleached very rapidly when exposed to light, and regained its purplish-red color again whenever light was withdrawn from it, it was thought that the true visual process had been discovered. Another fact appeared to fortify this supposition, namely, that some of the colored light-rays bleach this visual purple more rapidly than others. This would seem to provide a physiological basis for the qualitative differences in colors. But the fact that visual purple is not found on the fovea, the area of clearest vision and, moreover, that vision is not diminished after the visual purple is exhausted, make it highly improbable that the activity of the visual purple is the real visual process. However, a number of facts indicate that the visual purple increases the sensitivity of the eye in very dim illumination, *i. e.*, in twilight vision. It is a very common observation that when we pass from a very light room into the dim illumination of the night, at first we are unable to see at all. But gradually the eye adapts itself to the darkness, so that we can see well enough to get about. Or, when passing from the dark into a lighted room, the light is at first so brilliant that a short period of light-adaptation is necessary before the eye can react properly. It is quite probable that the building up of the visual purple on the rods in the dark makes them more sensitive to dim light, and that by its means the eye becomes "dark-adapted." It is known that the visual purple builds up more slowly than it bleaches out, which is in agreement with the fact that the eye adapts itself more slowly to the dark than to the light. Still another interesting fact to be considered in this connection is that the fovea, which contains only cones and no visual purple, is practically blind in very dim light. All this makes it very probable that the function of the purple is to increase the sensitivity of the rods to dim light. The eyes of bats and other nocturnal animals have practically no cones, but the rods, which are present in great numbers, are liberally supplied with visual purple.

It seems, therefore, that the rods and cones of the eye perform different functions: the rods for *twilight* and the cones for *daylight* vision. The rods give sensations of light when the illumination is too low to stimulate the cones to activity. It is also probable that the rods furnish us with sensations of brightness or colorless light only, and that the cones furnish us with our color-sensations in addition to sensations of brightness of moderate intensity. In very dim light (deep twilight), when the fovea is blind, no color can be seen. All colors then appear as gray. The sensitivity of the eye to color is greatest at the fovea, and decreases as the cones decrease in number toward the periphery, where the eye is absolutely color-blind. There are other facts which point in the same direction, but these are sufficient to indicate a differentiation of the rods and cones with regard to light-sensations.

**Stimulus.**—The adequate stimulus for visual sensations is the vibrations of ether, which is supposed to be the medium by means of which light is transmitted. The eye may be stimulated inadequately by purely mechanical and electrical energy. A blow on the head may cause us to see stars, or fill the field of vision with sudden light. By pressing upon the outer surface of the closed eye, *phosphenes*, or circles of light, may be seen in the inner field of vision. An electric current will also arouse sensations of light when passed through the eyes. The physiological processes which are going on in the retina itself also act as a stimulus. On closing the eyes and covering them to exclude all external light, we find that instead of absolute darkness the eye is dimly illuminated with its own light (*Eigenlicht*), giving an ever-changing cloud effect.

But, as we have said, the normal stimulus is the wave movement, or vibrations of ether. The eye is sensitive only to the ether-vibrations which lie between the infra-red and the ultra-violet vibrations. Ether-rays below the red and above the violet arouse no visual sensations, although they are known to exist. The light-rays that stimulate the eye are all contained in the spectrum, whose vibration rates are approximately as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Fraunhofer line | *B*, Red, | 450 | trillion | vibrations | per | second |
| " " | *C*, Orange, | 472 | " | " | " | " |
| " " | *D*, Yellow, | 526 | " | " | " | " |
| " " | *E*, Green, | 589 | " | " | " | " |
| " " | *F*, Blue-green, | 640 | " | " | " | " |
| " " | *G*, Blue, | 722 | " | " | " | " |
| " " | *H*, Violet, | 790 | " | " | " | " |

By inspecting the colors of the spectrum the student will see that each color is spread out in a narrow band. A single vibration rate cannot, therefore, adequately represent a color, for any color may have a number of different vibration rates. For instance, red is practically the same in appearance from 440 trillion to 460 trillion vibrations.

The red rays, the slowest in vibration rates, are the longest waves, while the more rapid violet waves are the shortest in length. The waves vary in length from red, 0.000687 mm., to violet, 0.000393 mm.

Thus we see that the quality (hue) of sensations of color depends upon the wave-lengths, or the vibration frequencies of light. For example, vibration frequencies ranging around 450 trillion per second give the sensation of red, while those of 589 trillion give green. But the correspondence of change of vibration rate and change of hue is not uniform in all parts of the spectrum. At the lower end considerable change in the number of vibrations is required to cause a change in the quality of red. Green, on the other hand, changes its quality very rapidly, corresponding to a smaller change in the vibration rate of the stimulus.

When homogeneous light-rays (light-rays of the same length, or of the same vibration frequency) fall upon the cones, the resulting sensation is a pure color. But if the light-rays of all the differing frequencies are mixed, the resulting sensation is white. We may say in general that for normal daylight vision homogeneous or pure light-rays are the stimuli for the pure color-sensations; while a mixture of all the light-rays is the stimulus for the achromatic or colorless sensations.[1]

The colorless, white light of sunlight is a mixture of all the light-rays. When a beam of colorless light is passed through a prism, its different rays are bent at slightly differing angles, thus splitting up the complex white light into its constituent elements and forming the spectrum.

**Kinds of Visual Sensations.**—Visual sensations fall into two general groups: (1) The *achromatic* and (2) the *chromatic*. The achromatic or colorless sensations form a series from white through gray to black. Although there is a difference of opinion on the subject among psychologists, we shall consider white and black as different qualities of colorless sensations, and gray as a compound of white and black. The achromatic sensations, however, have but one stimulus (colorless light), which exists in various degrees of intensity. Black is the result of a very low degree, gray of a medium degree, and white of a very high degree of intensity of colorless light. It has been suggested that black is the absence of light-stimulation (the resting condition of the retina), and therefore corresponds to inactive brain centres, or at least brain centres which are receiving no nervous impulses from the retina. This negative conception seems unjustifiable. Every sensation is the result of stimulation of some end-organ and is, therefore, a positive experience. Even when we first enter the blackness of an absolutely light-proof dark room, where no external stimulus can reach the eye, the physiological processes of the retina itself cause minimal sensations of light, ordinarily considered as black. As soon as the eye becomes dark-adapted, the black becomes lighter. The ordinary blacks which we see in the outer world are certainly the results of stimulation of the retina. The negative conception would make "seeing black" equivalent to

[1] Certain modifications will be made to this general statement later.

seeing nothing at all (blindness). However, "seeing black" is quite different from "being blind." An object may transmit a considerable amount of light to the eye and yet appear black. Moreover, there is not a single black, but many different blacks, as he who has been commissioned to match a given black fabric at the dress-goods counter well knows.

Besides the usual method of arousing sensations of the white-gray-black series, namely, stimulation by light-rays of all wave-lengths acting simultaneously upon the retina, there are several other means of arousing them: Any two complementary colors when mixed will produce gray; very small areas of colors, or any color in very faint light, or color falling on the periphery of the eye will be seen as gray.

The chromatic sensations, or sensations of color, form a very large group of sensory experiences, not only the experiences of the colors of the spectrum, but also the thousands of tints, shades, and mixtures, which are derived from them. The spectral colors themselves, or rather the sensations which we get from them, are not all elementary. Considering the colors of the spectrum, beginning at the lower end, we have red, orange, yellow, green, blue, indigo-blue, and violet. It is evident that orange partakes of the qualities of red and yellow, and that indigo-blue and violet are mixtures of blue and red. This leaves *red*, *yellow*, *green*, and *blue* as the elementary sensations of color. Each one of these four colors possesses a color quality totally different from the others, and each quality is simple and unanalyzable. There are, then, just four kinds of color-sensations—red, yellow, green, and blue. All others are compounds, formed out of the elementary sensations. This classification, being purely psychological, does not in any way conflict with the classifications of the colors made for other purposes.[1]

[1] The artist classifies colors into three primary colors—red, yellow, and blue. The physicist also reduces colors to three—red, green, and blue-violet, which he names *fundamental* colors. The physiologist speaks of four colors (purple-red, bluish green, blue, and yellow) as invariable or staple colors.

**Brightness of Colors.**—The spectral colors are not all of equal brightness. In ordinary daylight illumination, yellow is the brightest and violet the darkest color, *i. e.*, yellow is nearest and violet farthest away from white. Since the grays form a series of increasing brightness from black to white, it is possible to match the brightness of any one of the colors with some degree of gray. In this way we can determine the brightness of the colors. We shall find that yellow will correspond in brightness to a gray which stands higher up (nearer white) than the gray which corresponds with any of the other colors. Violet corresponds with a gray lower down, *i. e.*, farther away from white. (See the color pyramid, Figure 59.) Now, if the illumination of the spectrum is increased in intensity, all sensations of color tend to disappear and the spectrum appears washed out or whitish, and at the maximum intensity all colors become white. Yellow and blue hold their colors longest. If, on the other hand, the illumination (brightness) of the colors is reduced, the colors become darkened and finally change into colorless lights of low intensity.[1] In general, then, we may say that when color-stimuli become sufficiently intense, the colors are seen as white; if they become sufficiently feeble, colors are seen as dark gray or black.

**Purkinje Phenomenon.**—An interesting fact, known as *Purkinje's phenomenon*, may be observed when the eye becomes dark-adapted and the illumination of the spectral colors reduced to a minimum. In ordinary light, when the eye is light-adapted, the brightest color in the spectrum is yellow, but when the illumination is very dim and the eye becomes dark-adapted, the region of *maximum brightness changes from the yellow to the green.* The reds become relatively darker, while the blues become brighter. This change of brightness takes place only when the eye becomes dark-adapted, and consequently it does not occur in foveal vision. The Purkinje phenomenon, therefore, appears only when the

[1] Red appears to hold some of its color until it disappears altogether.

eyes shift from daylight to twilight vision, and become dark-adapted.

It is interesting to note in this connection that when a dark-adapted eye is exposed to different colored lights, the visual purple is bleached most rapidly by green light, next by blue light, and least of all by red light. This may explain the relative degrees of brightness of these colors in a dark-adapted eye.

**Saturation.**—It is quite evident that there is considerable variation in each of the four kinds of color-sensations. For instance, there are many colors which we may call *red*, many that may be called *blue*, etc., but the purest red, the *saturated red*, is found in the spectrum. Likewise, all the other colors are purest or most saturated in the spectrum. *Saturation* refers to the degree of purity of a color, its freedom from admixture with other light-waves. So a color is said to be saturated when it contains little white light—when it is as little like white as possible. We never experience absolutely pure or completely saturated colors. There is always some white light in any color, but those of the spectrum are the nearest approach to saturation. Of these, red and blue are most, while yellow and green are the least, saturated.

**Complementary Colors.**—If we examine the spectrum, we find that adjacent colors shade off into each other gradually; red shades into yellow through orange, yellow passes into green through greenish yellow and yellowish green, green into blue through bluish green and greenish blue, and blue passes back to red through the violets, so that the colors, instead of forming a straight line, may be arranged in a circle, or rather as a square, since the color quality changes abruptly four times in making the circuit from red back to red again. Now, between any two adjacent colors lie mixtures of the two colors, which possess the color qualities of both. If, however, we select pairs of colors not adjacent to each other, such as yellow and blue, there is no way of passing from one to the other through intermediate colors. When we mix such pairs of colors, instead of giving a spectral color of intermediate hue, they tend to neutralize each other and produce a gray. Such colors are said to be *complementary* colors. Complementary colors are those colors which, when mixed, give gray. Thus yellow and blue are complementary colors. Some of the other pairs of complementary colors are red and bluish green, orange and greenish blue, green and reddish purple.

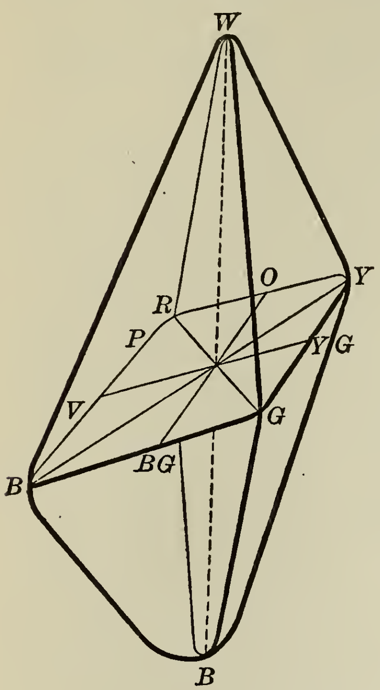



FIG. 59.—The color pyramid. (From Titchener's "Text-book of Psychology.")

**The Color Pyramid.**—A simple scheme for representing the relations of color-sensations to each other and to the white-gray-black series can be made by arranging the colors in the form of a double pyramid, and placing the grays along the axis connecting the two poles.

This double pyramid represents the two systems of sensations—sensations of light and sensations of color. Around the base (or, rather, where the bases join) we may arrange the saturated colors in the order of the spectrum. In fact, we may consider the straight line of the spectrum bent in four places (in the red, the yellow, the green, and the blue), to form a square. We may add purple to make the connection between violet and red. Along this line lie all the spectral or saturated colors. Orange lies between red and yellow, yellow-green between yellow and green, blue-green between green and blue, and violet and purple between blue and red. The eye can detect from 150 to 160 different spectral colors. The white-gray-black series is arranged along the straight line joining the upper apex with the lower, white at the top and black at the bottom, with all the intermediate grays between. There are about 700 different degrees of gray, from the whitest white to the darkest black. The middle gray is at the point where the line joins the base. Along the lines from the corners of the base to the upper apex lie all the tints of the colors, from middle brightness to white, while along the lines from the corners to the lower apex lie all the shades between the colors and black. For instance, between blue and white there is a series of tints of blue, which start with blue of middle brightness and gradually fade out into white. Likewise, between the blue and black is another series, which we may arbitrarily name "shades,"[1] beginning with blue and ending with black. So with all the other colors represented on the base of the double pyramid. If, now, one pass from a saturated color on the outer rim of the base toward the centre of the pyramid, another series of colors, becoming less and less saturated and ending at the centre in neutral or middle gray, is represented.

The results of mixing colors are roughly indicated in the pyramid. Mixtures of any two colors lie on the straight lines between the colors mixed. If red and yellow are mixed the result is an orange, which is found on the line in the pyramid between the two colors. A mixture of white and black gives a middle gray. If two complementary colors, say yellow and blue, are mixed, the result, gray, is likewise found on an imaginary line joining the colors in the pyramid.

The difference in the brightness of the spectral colors is represented by the angle which the base makes with the white-gray-black line. Yellow, being the brightest color, is, therefore, found nearest white and corresponds in brightness to the gray represented directly opposite on the dotted line. Blue, having a lower degree of brightness, is farther away from white, and is, therefore, matched with a gray lower down on the dotted line.

[1] The use of the word "shade" in this restricted meaning is purely arbitrary and technical.

The number of different sensations of light and color, tints and shades, and their mixtures, which the eye can see and which must be represented upon the surfaces and in the volume of the color pyramid, is very large. It has been variously estimated from 33,000 upward.

**Color Mixtures.**—By superimposing two different colored lights upon the same retinal surface we get a mixture of the two colors. The simplest way to mix colors is to place them on a cardboard disc, which can be made to revolve very rapidly on a color-wheel. In this way a disk having two or more different colors will, when revolved rapidly enough, give a smooth, even color, which is the mixture of the given colors. For instance, if a disc having all the colors on it is revolved, the result is an even neutral gray. If a disc is half red and half yellow, the mixture will be orange; if half yellow and half blue, the mixture will be a gray, and so on. Thousands of mixtures of saturated colors, tints, and shades with each other and with the whites, grays, and blacks may be made in this way. The most important principles of color-mixing are as follows: (1) When complementary colors are mixed in the proper proportion the result is a gray; if not in that proportion, they will give a washed-out or unsaturated color of the same quality as the preponderating color. Thus, if a large part of the disc is blue and only a small part yellow, the mixture will be an unsaturated blue. (2) When colors that are not complementary are mixed, the result is an intermediate color. The hue will vary with the relative amounts of the two colors. If blue and green are mixed, the result is an intermediate blue-green; if the relative amount of green is large, the mixture will be a green tinged with blue; if, on the other hand, blue forms the larger part, then the mixture will be blue tinged with green.

**Light and Color Adaptation.**—The quality of a light or color sensation is modified by the length of time the stimulus has acted upon the retina. This is due to the adaptation of the end-organs to the stimulus. When dark glasses are first put on, everything appears dark, but after a time the darkness wears off. Likewise, when colored glasses are placed before the eyes, their color is strongly marked, but later it may disappear altogether and objects will appear in their normal colors. The change which a color undergoes as the stimulus continues may be observed. Look steadily at a saturated red with one eye, while the other is closed. After one minute compare the red seen by the adapted eye with the same red seen by the non-adapted eye. The red of the adapted eye appears much less saturated than that of the non-adapted eye. If color-stimuli act on the retina for a long period, they become less and less able to arouse color-sensations. Brightness-stimuli also become less and less able to arouse their original sensations as they continue to act. In general, we may say that, as the process of adaptation continues, all sensations of brightness and color tend more and more toward their opposites. If we gaze at a white cardboard it becomes darker; if we gaze at black it becomes lighter. So with colors; they tend to lose their saturation as the stimulus continues.

The effect of adaptation to any light and color stimulus not only blunts the sensitivity for the given stimulus, but it also increases the sensitivity of the retina for the opposite or complementary color. When we go from the yellow lamp-light of a closed room into the daylight, everything looks bluish. Gaze steadily at a sheet of yellow paper for thirty seconds, then at a neutral gray surface, and observe that the gray is tinged with blue. After adaptation to any color, a neutral gray will appear to possess the tint of the complementary color. It seems, then, that any light or color stimulus sets up not only its own retinal process, but tends also to set up the opposite process. This tendency shows itself in the negative after-images, or after-sensations, of light and color. If we fixate a small blue square for a short time and then look at an even gray surface, the after-image of the square will appear in a yellowish tint. The negative after-image of a window filled with sunlight is just the opposite of the original sensations in distribution of light and dark parts; the panes appear dark and the sashes light. Negative after-images of color and brightness are the opposites of the original sensations. The after-effect of adaptation is always in the opposite direction.

**Successive Contrasts.**—The tendency of visual stimuli to set up opposite sensory processes is responsible for the so-called successive contrast effects. After adaptation to white, a dark gray appears darker; after becoming accustomed to yellow, blue appears bluer; and so on. That is, after white, gray is darker, and after yellow, blue is bluer "by contrast," as we commonly say.

**Simultaneous Contrasts.**—In successive contrasts, the effects are wrought upon the same retinal areas. But in simultaneous contrasts, different areas of the retina are concerned. The stimulation of one part of the retina affects or modifies the action of other parts. Here, as in adaptation, the contrast effect is in the opposite direction. For instance, a small gray square surrounded by a colored field always appears tinged with the color complementary to the surrounding color. A gray surrounded by a bluish green becomes markedly reddish by contrast. The blue-green sets up the complementary color process in the part of the retina stimulated by the gray. It has been suggested that the bluish-green photochemical activity of the surrounding retinal field draws from the gray retinal field certain chemical substances essential for the bluish-green process, and leaves the gray field more sensitive to the complementary red stimuli which are present in gray light. On the other hand, it has been suggested that the contrast effect is of central origin and not retinal at all.

Besides the color contrast, we also have the brightness contrast. A small gray square on a white background will appear much darker than it really is. On a black background it seems much lighter than it really is.

Edge contrasts are very pronounced. If two sheets of colored papers, saturated red and green, or blue and yellow, are placed so that they partly overlap, along the edges where the papers meet, there will appear two narrow margins of intense color, one of intense red on the red paper and one of intense green on the green paper. This is caused by slight eye-movement, which allows a small strip of the retina which has become adapted to one color to be stimulated momentarily by the complementary color, for which it has been made more sensitive by its previous stimulation; hence the increased intensity of the sensation.

Most marked color contrasts are seen when a narrow strip of gray paper is laid across several sheets of paper of the different spectral colors, and over all of which is placed a larger sheet of thin tissue paper. The gray strip then becomes strongly tinged in its different parts with the colors complementary to its several backgrounds. The part of the strip lying over the blue sheet appears to be yellow, while the part over the yellow sheet is blue; over the red sheet it appears greenish and over the green sheet it appears reddish. This is usually spoken of as the *Meyer Experiment.*

Contrast effects are also very marked in shadows cast in colored lights. If an oil-lamp is lighted in daylight the shadow of any object cast on an uncolored surface, such as that of a white table-cloth, is strongly tinged with blue. The shadow, itself gray, is surrounded with the yellow lamplight and by contrast appears blue.

In general, contrasts are more evident the nearer together the contrasting surfaces lie and the more nearly they are of the same degree of brightness. The more saturated the colors the greater the color contrast. Differences in texture in contrasting surfaces and division lines or boundaries of any kind tend to destroy contrasts. It should be noticed that simultaneous contrasts are set up immediately, before adaptation has had time to operate. This indicates that contrasts are at least partly independent of adaptation.

It is evident that while the character of sensations of brightness and color is primarily determined by the nature of the stimulus (wave-length, amplitude, and composition of light-waves), nevertheless these sensations are modified by contrasts and by adaptation of the sensory end-organs.

**Color Zones of the Retina.**—We may call attention here to the differences of color sensations aroused on different parts of the retina. Ordinarily, what we attend to in the field of vision falls upon the central part of the retina, and so, unless our attention is especially called to it, we are unaware that objects in the outlying parts of the visual field are always seen without color. This absence of color is explained by the fact that the outer zone of the retina is totally color-blind. By means of the "perimeter," the parts of the retina that are sensitive to color-stimulation may be determined. Light from a small red disc, when it falls upon the outer zone or periphery of the retina is seen as black or very dark gray. If the disc is then moved so that its image approaches the fovea or centre of the retina, it will change to a yellow, and finally a point will be reached nearer the fovea, where it will be seen in its true color. So with the other elementary colors, except that the points at which they appear in their true colors differ.

The retina has three zones which respond differently to color-stimuli. Figure 60 shows a map of the color zones. The color zones differ somewhat in contour for different individuals, but in the relative positions of the zones they are the same.

The outermost zone responds only with sensations of colorless light, no matter what the nature of the stimulus is. The intermediate zone gives sensations of yellow and blue in addition to white-gray-black; while the innermost zone responds with all sensations of color and light. With stimuli of equal intensity and saturation, the red and green zones tend to coincide; likewise the yellow and blue. So we may speak of the green-red zone, the yellow-blue zone, and the white-black zone. These zones are not absolutely fixed, but

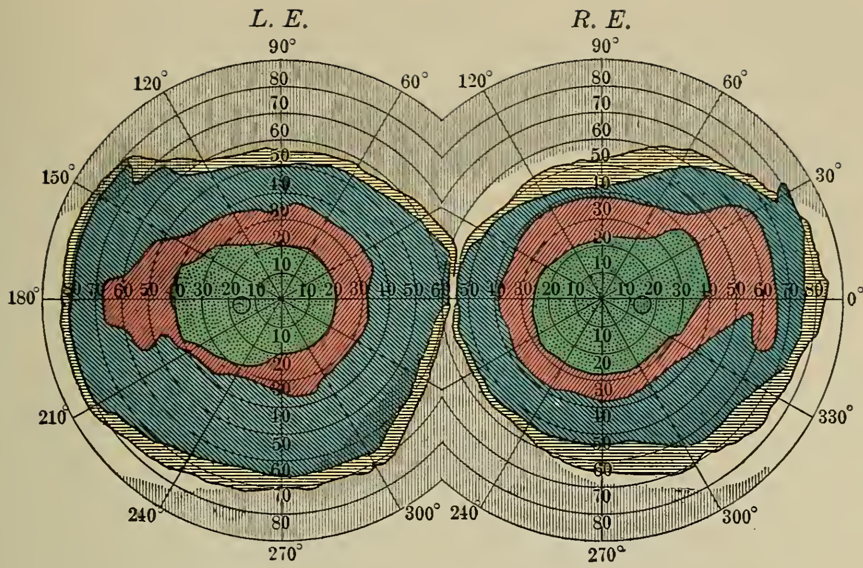



FIG. 60.—Perimeter chart of the color zones of the retinæ.

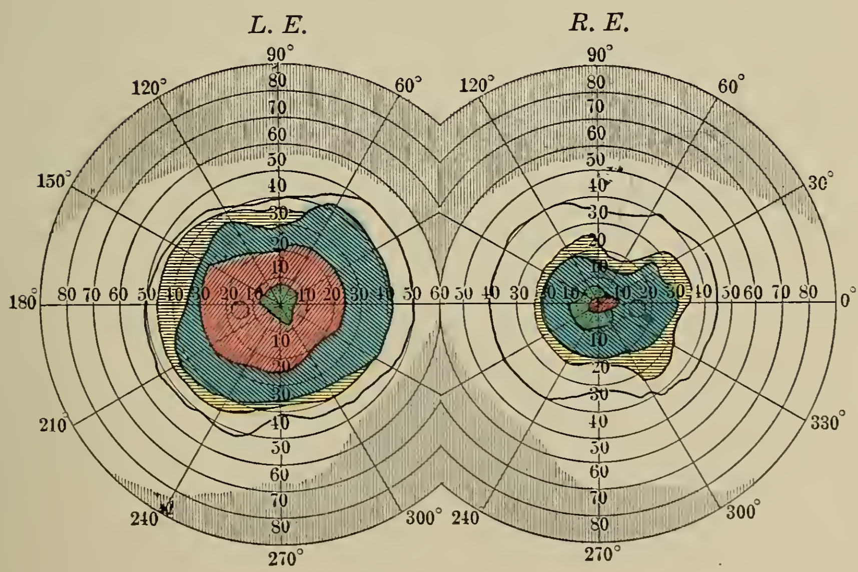



FIG. 61.—Color zones in a case of red-green blindness.

vary with different intensities of color-stimuli. The map here given was made with stimuli of moderate intensities.

**Color-Blindness.**—A considerable number of persons are lacking in color-vision. It is estimated that about 3½ per cent of the male and 2 per cent of the female population are color-blind. The most common form of abnormal color-vision is *partial color-blindness* (dichromasia), although there are a few cases of total color-blindness (achromasia). *Partial color-blindness* almost always exists as red-green blindness. Persons thus afflicted are unable to sense red and green. They see all the colors of the spectrum as yellows, blues, and grays. They, therefore, live in a world of two colors only. The reds, oranges, yellows, and parts of the greens appear to them in various tones of yellow, some of the greens and blues that lie next to each other in the spectrum appear as gray, while the rest of the blues and the violets appear as blue. In other words, they see the spectrum as a band of yellows in its lower part and a band of blues in its upper part, with a narrower band of gray between. Some of the reds at the lower part of the spectrum are also gray for the color-blind. The red-green blind, therefore, confuse red and green. If such a person were asked to match a red from a pile of many-colored yarns, he would pick out greens, grays, browns, and reds. Likewise, when attempting to match a green, he makes equally glaring errors. As an engineer or pilot he would make serious blunders in reading red and green signal-lights. This, of course, suggests the necessity of color tests for all who seek to enter such occupations. Figure 61 shows the color zones of a subject who is red-green blind in the right eye, with restricted color-vision in the left eye. (Notice that the red and green zones of the right eye are practically absent.) Cases of yellow-blue blindness are very rare. The cases that have been reported are pathological and not congenital, as are most of the cases of red-green blindness.

Total color-blindness is, in nearly every case, congenital. The totally color-blind see all colors as different intensities of gray. They, therefore, live in a colorless world. The spectrum appears as a band of grays, lighter in the centre and shading off into darker grays toward both ends. The totally color-blind eye is a dark-adapted eye; the maximum brightness of the spectrum is, for all illuminations, in the region of the green, and the fovea is in some cases permanently blind, so that an object in the outer world cannot be fixated directly. This is the reason why totally color-blind persons jerk and twitch the eyes about (nystagmus) in their attempts to see clearly. It is probable that the total color-blind vision is rod-vision. Although usually inherited and congenital, in some cases color-blindness has been acquired either by the prolonged action of colored lights upon the retina, or through the use of drugs (nicotin, santonin), or by certain diseases of the retina. In its acquired form it may sometimes be limited to certain definite portions of the retina, leaving the rest of the retinal areas normal.

Persons with normal color-vision do not all possess the same sensitivity for colors. Some show what has been called "anomalous" color-vision. They are not really color-blind, but their color-vision is disturbed. While they can see all the colors, they do not match them as the perfectly normal person does, indicating that the colors are not exactly the same in quality for them.

**Color Theories.**—We have already seen that the difference between colorless and color vision is explained by the theory that the former is the function of the rods, while the latter is attributed to the cones of the retina. But we have made no attempt to explain how the eye makes the further distinction of color-vision. What is the basis for the four elementary color-sensations? Are there four kinds of cones, one kind for red, one for yellow, one for green, and one for blue, each sensitive to light-waves of a certain length only? Such a theory is evidently too simple to explain the facts of color-vision. For example, how could we then explain the fact that certain colors, when mixed, produce colorless, while others give intermediate color sensations? Yellow and blue give gray, while yellow and red give orange. Furthermore, why does adaptation to yellow increase the sensitivity to blue and not to red? These and other facts show that the relation between the four elementary color-sensations is not uniform. A color theory must be able to explain all the facts of adaptation, complementary colors, after-images, color mixtures, contrasts, and color-blindness. While a number of theories of color-vision have been proposed, no one has absolutely met this requirement.

**The Young-Helmholtz Theory.**—This theory, first proposed by Young and later modified by Helmholtz, is based upon the assumption that there are only three elementary colors—carmine red, slightly yellowish green, and ultramarine blue. It is supposed, according to this theory, that there are three photochemical substances in the retina, which correspond to these color-sensations. The red substance is chiefly affected by the longer waves (red waves); the green substance by the medium waves (green waves), and the blue substance by the shorter waves (blue waves) of the spectrum. All the color-sensations, together with white, are the result of the activity of these three retinal substances. Each substance is supposed to be affected somewhat by any light-stimulus, but *chiefly* by its own appropriate stimulus. Thus, while red light has its greatest effect upon the red substance, it also affects the other substances slightly. Equal excitation of all three substances gives achromatic sensations. Any color would then have some brightness in it. This would account for the fact that colors are never completely saturated, or pure. Black is the absence of stimulation. Complementary after-images are due to fatigue of the photochemical substance stimulated. The other substances, then being fresh, react more powerfully to a gray stimulus, giving the complementary after-image. Color-blindness is due to the absence of one or more of the substances in the retina.

There are several serious objections to the theory: If white is the compound of all three colors, then in partial color-blindness, where one color is supposed to be absent, the sensation of white would be impossible. This is contrary to fact, for in cases of partial color-blindness in one eye only, white appears the same to both eyes. Moreover, in total color-blindness, sensations of white are still possible, although all the components of white, according to the theory, are absent. The fact that a mixture of green and blue gives a sensation (blue-green) *like* both components, while a mixture of green and red gives a sensation (yellowish gray) totally *unlike* either component color, is not satisfactorily explained by the theory. In fact, the most serious defect in the theory seems to lie in that it does not recognize yellow as an elementary color, but considers it as a compound of red and green. In the intermediate zone of the retina and in red-green blindness, color-vision is yellow-blue vision. In these cases yellow cannot be compounded from red and green, since they are absent. Furthermore, yellow and blue are complementary colors here, as well as in normal and central vision. It would therefore seem that yellow is as elementary as blue, or red, or green, making four instead of three elementary colors.

**Hering Theory.**—The Hering theory recognizes four elementary color-sensations, *red*, *yellow*, *green*, and *blue*, and two elementary colorless sensations, *white* and *black*. They exist in three pairs, the members of each pair standing in opposite or complementary relation to each other. The pairs are red and green, yellow and blue, and white and black. For each pair of sensations it is assumed that there is a single photochemical substance which has two antagonistic chemical processes—a dissimilative and an assimilative process. There are then three visual substances in the retina: a red-green substance, a yellow-blue substance, and a white-black substance. Red, yellow, and white light break down or cause dissimilation, while green, blue, and black light build up or cause assimilation in these three substances respectively. For instance, red light breaks down the red-green substance and green light builds it up. After the dissimilative effect of red light, the red-green substance tends to recover equilibrium, *i. e.*, assimilation sets in. This explains the green after-effect of red stimulation. Any color-stimulus not only acts upon its own substance, but also acts upon the white-black substance. This explains why all colors possess brightness. In case complementary colors (for instance, yellow and blue) act equally upon the yellow-blue substance at the same time, they neutralize each other, but, since they affect the white-black substance also, the result is a sensation of gray. If, however, these colors affect the white-black substance in equal but opposite ways, the retinal substances would all be in equilibrium, and the gray which results is supposed to be a cortical gray (a neutral or middle gray), which originates in the brain centre and corresponds to the absence of retinal activity. This neutral gray is supposed to be constantly present in vision and to mix with all visual sensations. Only when the given complementary colors affect the white-black substance in different directions unequally, or both affect it in the same direction, so that either assimilation or dissimilation takes place, is the resulting gray (light gray or dark gray), a retinal gray. The color zones of the retina are supposed to be determined by the presence or absence of the different substances. The cones of the innermost zone contain all three substances, those of the intermediate zone only the yellow-blue and the white-black substances, while those of the outermost zone contain only the white-black substance. Contrasts are due to the fact that any direct action of a stimulus on a part of the retina sets up a process of opposition in the parts not stimulated.

We may object to the Hering theory on the ground that one-half of all the light and color sensations must be due, according to the theory, to an assimilative process in the substance of the sensory end-organs. This opposes our ordinary conception of the effect of stimulation. Furthermore, the conception of the so-called "cortical gray" makes an exception to the general rule that all sensory experiences originate in sense-organ stimulation. According to the theory, however, the conception of the cortical gray is necessary. For, if the white-black substance is antagonistic, as the other substances are, in its activities, then when both white and black stimulate it equally, the result must be no sensation at all. But, since in fact we get gray under these circumstances, the theory was forced to assume that it is a cortical and not a retinal gray.

**Ladd-Franklin Theory.**—Mrs. Ladd-Franklin has proposed a genetic color theory, which assumes that our present color vision is a development from a primitive stage of colorless vision. Such a condition now exists in the outermost zone of the retina, but the central portion of the retina has developed away from its original state, and now is able to produce color-sensations. The theory assumes a single photochemical substance in both the rods and cones. But in the rods it exists in its original, undifferentiated form, in which any light-stimulus whatsoever acts upon the molecule as a whole, breaking it down in all its parts and giving the sensation of gray. In some of the cones the elements of the molecule have been differentiated into two parts, such that one part is affected only by the longer waves of the spectrum and gives the sensation of yellow, while the other part is affected by the shorter waves and gives the sensation of blue. These cones are found in the intermediate zone of the retina. In the other cones, found only in the innermost zone, the yellow compound has been further differentiated into two groupings, such that red light affects one and green light the other. The three stages of development may be represented as shown in Fig. 62.

In the first stage the photochemical substance acts as a whole. In the second stage the two parts may act separately. In the third stage the three parts may act separately. According to the theory, complete decomposition of the

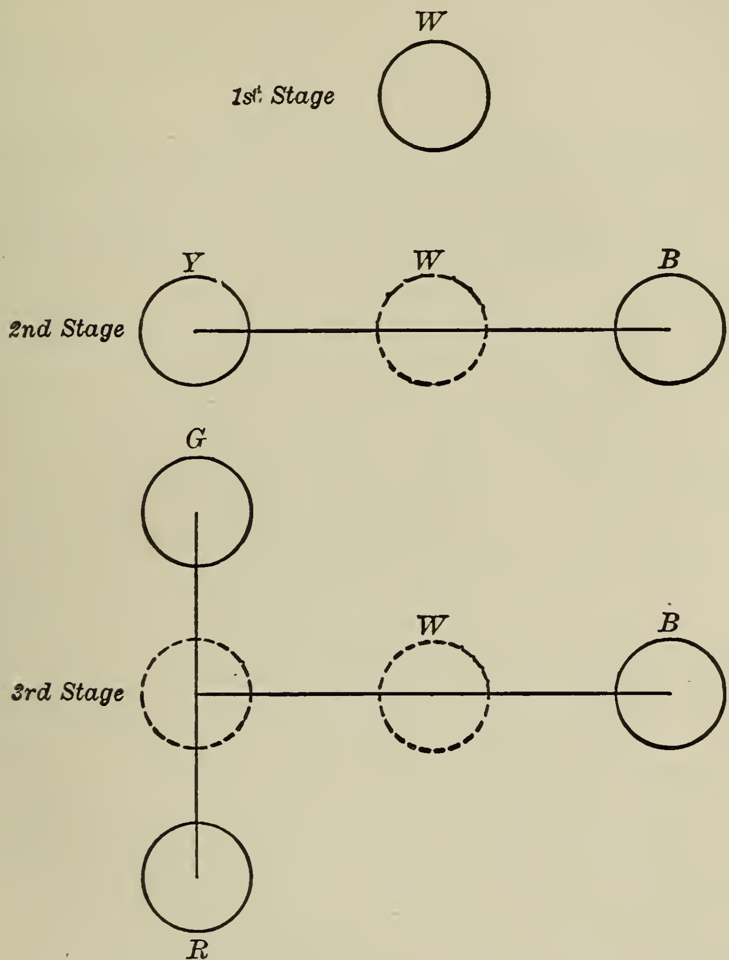



FIG. 62.—Scheme to illustrate the Ladd-Franklin theory of color-vision. After Ladd-Franklin.

photochemical substance gives sensations of gray or white. Partial decomposition gives color. Thus, if both yellow and blue light act upon the yellow-blue cones, the result is the original sensation of colorless light, since both stimuli, when acting together, break down the molecules completely. If green and red act upon the green-red-blue cones, they arouse the sensation of yellow, but if green, red, and blue all act upon these cones, the original sensation of white or gray is aroused. If any color-stimulus acts alone, the molecules are only partially affected, and so produce sensations of color. One of the advantages of this theory is that it provides a common basis for peripheral gray, gray of very faint light, and the gray produced by mixing colors.

Many other theories have been proposed, but the theories mentioned are the representative theories, and they serve to show us the nature and the difficulties of the problem of color-vision.

## CHAPTER IX

## PERCEPTION

**Perception of Objects.**—We have seen that sensation is the consciousness of the *qualities* of objects. Perception, on the other hand, is the consciousness of objects, the result of the presentation of a group of physical qualities to the senses. For instance, we do not say that we have the sensation of the rose, but rather that we *perceive* the rose. We may sense its simple qualities one by one, but when color, form, tactual qualities, and fragrance are experienced all at the same time, we are aware of an object. The perception of a rose is not, however, the sensation of color plus the sensation of form, plus the sensation of fragrance, etc., it is a unitary experience—an experience of a single object and not of a group of separate qualities.

We may consider sensation as the awareness of the qualities of an object, while perception is the consciousness of the qualities of an object synthesized into an object. In sensation, what we experience is determined by the stimulus. On the other hand, in perception we supplement and interpret the presented stimuli by past experiences. We are conscious of more than the group of sensations given by the stimuli. Past experiences are awakened and are synthesized into the percept. Perception is the consciousness of sense-impressions interpreted in terms of past experiences. In the perception of a book we are not only conscious of what the senses give, but of much more—its closed pages, printed words, chapters, cuts, etc., which are not presented to the sense-organs. My perception of apple includes the consciousness of it as a solid, as having a white, juicy pulp, and as having another side which is turned away from me. Here we have reinstatements of past experiences with books and apples entering into the present percept. If we have had no past experience with books and apples, another group of revived images may supplement the sense-impression when these objects are presented to us. We might then perceive the book as a flat box and the apple as an imperfect ball. A little girl from the tenement quarters who had never seen ferns of any kind called a large, flowing fern "a pot of green feathers." If an object which is entirely unlike anything we have known is presented to us, it will be experienced as a mass of sensation, having no significance for us—a bare sensory consciousness. Such a state of consciousness rarely occurs, however, for it is difficult to find an object wholly unique and not in some way related to past experience. Our simplest awareness of objects is supplemented by the modifications of past experiences. Sometimes, however, the amount of supplementation is very small. To one listening to the spoken words of an unfamiliar language, the words appear as a series of meaningless sounds—naked sensations, so to speak. No supplementation from past experience takes place, and consequently perception reduces to mere sensations of sound.

More often than we think is the consciousness of objects supplied out of our own minds. I perceive the angles of the rectangular table in front of me as right angles, although the sensory stimuli form two acute and two obtuse angles for the position from which I view the table top. I perceive the angles as right angles, because I know from past experience that they are right angles. The sensations which I receive from the table are modified by the knowledge gained from past experience. How past experiences become assimilated into our perceptions is illustrated by the following incident: As I stood at the window one morning, my gaze fell upon the back yard of a familiar house some distance away. I was surprised to see that the yard, usually well kept, was filled with broken limestone. Wondering why the owner could so encumber his premises, I turned back to my work. When I looked up some moments later, I saw that the broken, white limestone was only the weekly wash hanging out to dry. I then remembered that just before looking at the yard in the first instance my attention had rested for a moment upon the unusually white limestone foundation of a house that was being built near by. The perception of the limestone foundation left its impress upon the mind to such a degree that the perception of the white linen was completely changed.[1]

The student will find in his own daily life abundant illustrations of the fact that what we perceive depends not only upon the stimuli affecting the senses, but also upon what we have perceived in the past. "Perception is not, as it seems, the mere entrance of a group of sensations, but an arousal of old experiences by a few newly entering sensations." [2]

This arousal of old experiences by incoming sensations has been popularly termed apperception, the usual meaning of the term being the process by which the "raw" material supplied by the senses is interpreted in terms of the knowledge already in the mind. But owing to the fact that the term has had various different meanings and is now used very loosely, a better term to apply to this process is *assimilation*. The sensory material which enters into perception is, we say, assimilated by past experiences. We use the term assimilation to indicate the fact that perception is "actual

[1] Several years ago I was very much annoyed for several weeks by the explosions of dynamite, which was being used to blast out the rock for a sewer on the avenue in front of the University. A year after the work was completed I was startled one day by hearing an explosion of dynamite directly in front of the University building. I immediately went to the window to see if the work had recommenced on the sewer line, but I was unable to locate any workmen on the street. It was empty. Within the next half-hour I distinctly heard several explosions. I was, however, unable to account for them until I discovered that the sounds that I had perceived as explosions came from a French casement window which had been opening and closing in the wind. The sensations of sound made by the slamming window had aroused the experiences of a year ago. So the interpretation of the sensation was determined by the former experiences.

[2] Pillsbury: "Attention," p. 128.

sensations modified and supplemented by past experiences." Past experiences play an important part in determining the character of presentations. They appear in our new experiences in various forms: vague images of previous sensations, motor tendencies, implicit judgments, meaning, and experiences of familiarity and recognition, any one of which may at times be scarcely raised above the threshold of consciousness, and may require very careful observation to detect its presence in perception. While past experiences are not always overtly present in the total process of perception, the nature of the percept oftentime shows that they have been determining elements in it.

There are, then, two important phases in the process of perception: (1) The reception of sensory impressions, and (2) the interpretation of these impressions through past experiences already in the mind. In every-day experience it is usually impossible to separate these phases from each other. The total conscious reaction to an object is immediately combined into a single experience. Sometimes, however, the process of assimilation, or interpretation, is retarded. The sudden presentation of an unfamiliar object may be followed by several attempts to perceive it correctly. In each the attempted assimilation takes different directions, using now one group of past experiences and now another. The stimulus may be followed by an appreciable interval in which no assimilation takes place. We are unable for the moment to interpret the sensations; then we "come to" and recognize the stimulus as some definite object. If by means of the tachistoscope, we expose to view a complex but familiar object for a few thousandths of a second, the period is too short to permit of a completed perception. The observer may get a group of sensations, but he is unable to organize them into the experience of an object. If the exposures are repeated, assimilation gradually takes place and finally the object is correctly perceived.

Brain pathology furnishes evidence of the existence of these two phases of perception. Cases of *asymbolia* have been recorded, where because of a certain brain lesion, patients are unable to recognize familiar objects, although they are able to see them plainly. They receive the sensations, but they are not assimilated by past experiences. Other brain lesions may result in *alexia*, or inability to read. The words may be seen but not understood. Still another form of brain lesion may be followed by *word deafness* or loss of the ability to recognize the meaning of spoken words, although the ability to hear the spoken words is not interfered with. It would seem in these cases that the action of higher units of brain centres involving assimilation is cut off from the sense centres by the diseased condition of the cortex.

Considered in neural terms, then, the basis of the process of assimilation consists in cortical modifications left behind by the previous neural processes, by virtue of which certain brain tracts are more pervious to stimuli than others. If by reason of past experiences a given brain tract (*A*) is more susceptible or more permeable to a given set of stimuli than another brain tract (*B*), the activity in the sense centres will be drained off by (*A*), thus giving the perception corresponding to the neural activity in (*A*). If we may suppose that there are perception levels in the cortex (*i. e.*, that perception involves the activity of higher or, at least, larger areas than those involved in simple sensation), they may be considered as figured with neural patterns, corresponding to the different objects experienced. We may presume that each particular class of objects leaves a definite system of modifications or object patterns[1] in these levels. If such a supposition describes anything like the real neural conditions in perception, then we may conclude that every group of stimuli (*i. e.*, every object) first arouses activity in the appropriate sense centres. The activity is then drained off into the particular cortical

[1] By "object patterns" we mean only that the effect of the experience of an object makes the neural structure more liable to act again in the same way when stimulations from like objects arouse it to activity.

tracts, or object patterns, which have been made permeable by past experiences, and which retain the modifications made by them. In this way past experiences are revived and in turn modify or supplement the sensations.

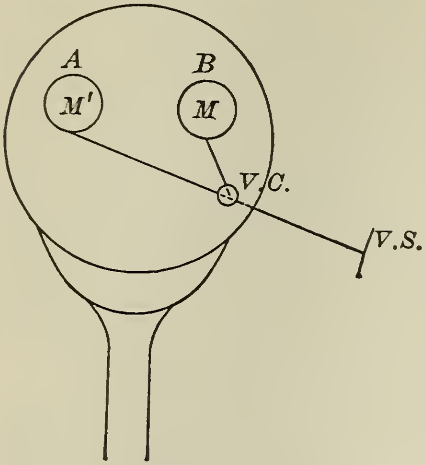



Fig. 63.—*V.S.*—Visual stimuli (back yard); *V.C.*—visual centre in cortex.

*A* and *B*, higher cortical areas; *A*, area involved in perception of yard filled with washing; *B*, area involved in perception of yard filled with limestone; $M^1$, modifications left by past experiences with white clothes; *M*, modifications made by recent experiences of white limestone foundation. If *V.C.* arouses *M*, then *B* becomes active, and the resulting perception will be "yard filled with limestone." If *V.C.* arouses $M^1$, then *A* becomes active and the resulting perception will be "yard filled with the week's washing." The "limestone" modification became dominant in the first perception because the experience of the stone foundation left certain areas temporarily more permeable than others.[1]

The diagram (Fig. 63) will make the matter clear without attempting to go into the details of the anatomical and physiological facts concerned.

It is probably not too much to say that all our higher conscious experiences develop out of our experiences of objects (perception). We were first introduced to a world of objects to which we had to react. Our first organized and unified experiences were therefore with objects. In order to react to them intelligently, it became necessary to know when an object was presented, not only what its presented characteristics were, but also to know instantly those that were not presented. This is possible only by the awakening of past experience with the object.

It was natural, then, for the various forms of consciousness to arise around the object, and to become amalgamated

[1] It is evident that the presence of the process of assimilation makes perception a very complex conscious experience. The description of perception would be clearer if we had defined it as merely the reception and synthesis of a group of actual sensations into a unified experience corresponding to an object. Supplementation of the actual sensations by revived sensations could then be considered in the chapter on imagination, recognition of the sensations

or synthesized into a single efficient act of consciousness. We shall expect, therefore, to find in perception the beginnings of imagination, judgment (recognition is a primitive form of judgment), and the concept (presence of meaning).

All three forms of consciousness are present in the process of assimilation, which involves three important products of past experience:

1. Revived sensory experiences.
2. Recognition.
3. Meaning.

We have already seen that the consciousness of an object contains sensory elements which are revived from past experience. In normal perception, the *revived sensations* are in keeping with the actual sensations received, and true to the sensible qualities of the object. If, however, we happen to supplement the actual sensations by a group of revived sensations which are not true to the object, the conscious result is an illusion. Usually in normal perception the proportional amount of actual sensation is large and the amount of revived sensation small. If, as may happen in rare cases under abnormal conditions, a set of revived sensations is presented with no accompaniment of actual sensations, but possessing the vividness of actual sensations, the conscious result is a hallucination.

**Complication.**—Complication is the term which we apply to the process in which an actual sensation of one of the qualities of an object brings up the other qualities with it. For instance, after my first experiences with ice, when I sense its coldness, its smoothness, its transparency, and its weight, I may, upon merely seeing a block of ice at a distance, be conscious of its coldness, its smoothness, and its heaviness

awakened by an object would be treated under memory, and the fact that any presented object aroused meaning (signified something beyond itself) would be treated under the concept. But no object is ever experienced without awakening past experiences and recognitions. The synthesis of the past and the present is quite as fundamental in perception as the synthesis of the different actual sensations into a unity.

without touching it. Instances of complication are very common. I may hear the note of a bird and the other sensations are revived into the perception. I may hear a bell and perceive a street-car, smell a pleasing odor and perceive a rose.

**Recognition.**—Recognition is a primitive form of judgment. Judgment, we shall see later, is the consciousness of some relationship existing between things. In its developed form the consciousness of relationship is explicitly experienced. In perception, recognition is implicit. When a familiar object is brought to our notice, we experience the relationship of the object *now* sensibly present to the same object or to similar objects as experienced in the past. When, for instance, we perceive a book, we instantly feel that it is familiar, that it is something that we have seen before. While we may not consciously represent to ourselves the related parts in the experience, yet it is nevertheless an elementary form of judgment. We implicitly feel the relation of the present group of sensations to our past experience with books.

**Meaning.**—A pure sensation has no meaning. It suggests nothing beyond itself. Pure sensation is the immediate awareness of a stimulus, before further knowledge is aroused. Perception, on the other hand, arouses further knowledge. Every object is presented to us with a background attaching to it. The background is the object's history, its associates, its functions, etc., so far as we have known them. The object, when presented, points out, signifies, suggests this background to us—in short, has meaning for us. The first meanings which objects had for us were actions. An object was a thing to be reacted to in a certain way—a bottle meant to-put-in-mouth, ball meant to roll, knife meant to cut.

The context or background which an object suggests may be very limited or very extended, according as our experience with it is small or large. As we become familiar with it it gathers meanings which are packed away in our perception of it. Now the thought or image of an object, carrying with it all the object's meanings, is a concept. The sensible presentation of the object, if it awakens a maximum of meaning, may function as a concept. If the emphasis in consciousness is placed on the meaning rather than on the sensible qualities of an object, the perception is conceptual in its nature. In so far, therefore, as perception involves meaning, it partakes of the quality of the concept. From the genetic point of view, perception is the beginning of conceptual consciousness. In the earlier stages of perception, the presence of the object awakened only consciousness of its sensible qualities and faint glimmerings of its meanings. Later, the object may come to be a mere symbol to which we attach a large number of meanings. When we say that an object is significant, it is plain that we are not interested in the object itself, but in the things that it suggests—its meanings. In a still later development, the name of the object may serve instead of the object to arouse consciousness of its meaning. When perception becomes so highly symbolic, the sensible qualities of objects form a small, if any, part of the content of consciousness. But perception does not always develop into concepts. We are obliged to react in a practical way to the objects about us and we must therefore take note of their sensible qualities. Much of our mental life remains on the perceptual plane—consciousness of objects.

The *function of perception* consists in supplying a knowledge of the proximate environment of things, and thereby instigating movements of bodily adaptations. It is evident that if we were unaware of the presence and nature of the objects in our surroundings, we could not survive. Not only present sensory consciousness of the character of the object, but also past experiences of the object appear in perception and play a part in the control of movement. We may note in passing that perception of objects is most complete in just those features which call out our practical reactions. The objects that we handle and touch and work with produce in us the clearest perceptions.

The *truth* or *falsity* of any given perception is determined by further experience with the object perceived. If, on examination, the object fulfils all its functions and characteristics as I know them, then I consider my initial perception true; but if it fails to do this, I am forced to correct my perception of it. There is one other court of appeal: If other persons perceive the object as I do, *i. e.*, react to it in the same way that I do, I have a practical proof of the truth of my perception. If the white powder which looks like sugar tastes sweet and dissolves in my tea, and all the other persons at the table put it in their tea, I am practically sure that my first perception of it as sugar is true. But if it has a saline taste or if others put it on meat and potatoes, I must consider my first perception false.

**Illusions.**—If a group of sensory qualities of an object is supplemented by revived sensations that have no actual basis in the object, the perception is illusory. Illusions are due to the fact that we interpret actual sensations in terms of old and habitual experiences. Illusion is really an illustration of the orderly, uniform, or lawful procedure of the process of perception. If, for instance, I have always perceived the sensible qualities *abcdefg* as the object X, and now if *adebcfg* is presented, I am inclined by previous habit of assimilation to perceive it as the same object X. Sully gives the following definition of illusion:

"Illusions depend upon the general mental law that when we have to do with the unfrequent, the unimportant and therefore unattended-to and the exceptional, we employ the ordinary and the familiar and the well-known as our standard."

Aristotle's illusion strikingly illustrates the force of habit in perception. Cross the index and middle fingers of the right hand. Rub a pencil between the tips of the fingers. Two pencils are perceived. Better still, roll a pea or some round object of about the same size between the tips of the crossed fingers. Two objects are distinctly perceived, in spite of the fact that you know that there is only one. We have formed the habit of interpreting two simultaneous pressure sensations on two non-adjacent parts of the skin as coming from two objects. In most cases it has required two objects to touch the outer and the inner tips of these fingers at the same time. Now, when by virtue of the unusual position of the fingers, one object gives the same sensations, we interpret the sensations in the old way.

The reverse or opposite of Aristotle's illusion may be produced very clearly by touching the outer tips of the still crossed fingers with two objects. One object is then perceived.

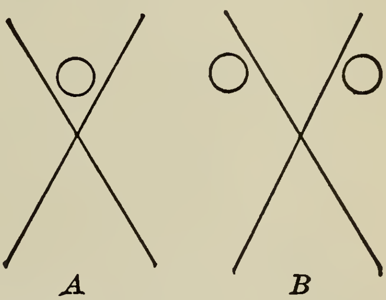



Fig. 64.—Diagram showing position of fingers: (*A*) Two objects perceived, (*B*) one object perceived.

A modification of this illusion may be produced by blindfolding a subject and testing the surfaces of his crossed fingers for the discrimination of distances between the two points of a pair of compasses. The shorter distances between the two points are uniformly judged greater than the longer distances, because in the normal position of the fingers the compass points must be farther apart in order to stimulate the same pressure spots.

If the concave side of a false face is painted to represent the features of the human face and set up at a distance of twenty-five feet or more, it will appear convex. Convexity is a universal characteristic of faces and so we read it into the actual sensations coming from the concave false face.

Illusions of movement are very common. Seated in a motionless railway-train, we may perceive our own train moving forward, whenever a train on the next track moves in the opposite direction. In actual perceptions of our own movement forward, other objects always appear to move backward. The railway-car situation furnishes this condition, the backward movement of objects. We consequently interpret it as our own movement forward. The same illusions may be experienced when we look down steadily at the water flowing under a bridge. Presently the bridge will appear to be moving up stream, carrying us with it. The illusion of levitation may be experienced during a heavy snowstorm, by gazing intently at the falling snowflakes and at the same time excluding everything else from the field of vision. The "magic swing illusion" in amusement parks is produced by revolving the entire room around the swing. To one sitting in the swing the perception of movement through a complete circle, over and over, is very realistic. All those illusions are due to our tendency to read into a group of actual sensations their usual accompaniments.

There is a second general cause of illusion[1] found in the fact that a temporary bias or tendency may be given to the interpretation of sensations by the "set" of consciousness at the moment sensory stimulation is received. The mind may be "full of the thought" of an object or may expect a certain object to appear. Then if the sensory stimulation is at all applicable, we are disposed to perceive that object, although it may really be another object that is presented. If I happen to be thinking intently about the Klondike goldfields, the word "cold" heard in a fragment of conversation in another part of the room may be perceived as "gold." We are very liable to overlook misspelled words in reading, because the context prepares the mind for the perception of the words in their correct forms. We may conclude that illusions are caused either by previous habits of interpretation, or by a momentary set of the mind.

[1] James gives two main causes of illusions: "The wrong object is perceived either because (1) although not on this occasion the real cause, it is yet the habitual, inveterate, or most probable cause . . . or because (2) the mind is temporarily full of the thought of that object. . . ." "Principles of Psychology," Vol. II, p. 86.

So far we have considered illusions as the result of the entrance of past experiences into the perception process. Illusions of this kind have been called "mixed illusions," *i. e.*, revived past experiences and actual sensations are combined or "mixed" in the perception of things. Such illusions are to be distinguished from those that are due to the effect of actual sensations upon each other, *i. e.*, illusions that are due to the nature of peripheral stimulations. Illusions of this kind are called "pure illusions." For instance, a square of white paper surrounded by a border of green is perceived

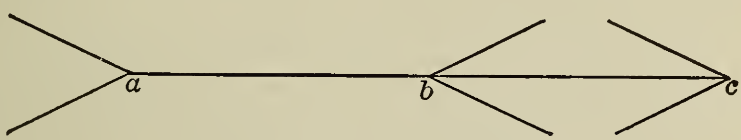



FIG. 65.—Müller-Lyer illusion.

strongly tinted with red. (Contrast effect.) The equal lines, *a–b* and *b–c* in the Müller-Lyer illusion are perceived as unequal.

In both of these illusions the presence of accompanying sensations apparently not included in the perception of the object is effective, nevertheless, in modifying or falsifying the perception. The presence of the green border and the oblique lines are instrumental in causing the illusions. The so-called "pure illusions" are constant in their appearance, always occurring under the given conditions. The "mixed illusions" are centrally aroused and variable, while the "pure illusions" are peripherally aroused[1] and constant.

It is claimed that illusions are not due to errors of sense,

[1] There is, however, a difference of opinion concerning the cause of the so-called "pure illusions." Some authorities contend that even in the perception of simple lines, as in the Müller-Lyer figure, suggestions from past experience enter into the illusion and that, therefore, centrally aroused factors play a part in the errors of simple perception. (See Ladd and Woodworth: "Elements of Physiological Psychology," pp. 447–453.) We can, at least, say that in the "pure illusions" the peripheral factors are more pronounced than in the "mixed illusions."

but rather to our judgment, or interpretation of sensations. James says: "The so-called fallacy of the senses of which the ancient sceptics made so much account, is not a fallacy of the senses proper, but rather of the intellect, which interprets wrongly what the senses give."[1] If sensation is taken to mean simply the conscious effect of stimuli upon us or within us, without reference to any existence in the outer world, then sensation cannot be said to be either false or true. Consciousness can be false only when it erroneously represents something beyond itself. An unprojected sensation of blue, for instance, cannot be false in itself. It is just what it is. When, however, it is taken as a quality of an object—a blue paper—then it is false, if it fails to represent the true color of the paper. The simpler the consciousness the less chance for falsification. A single sense-experience (when not modified by other experiences) reports correctly the sensible quality it represents.

**Hallucinations.**—The usual distinction between illusions and hallucinations consists in regarding illusions as the erroneous perception of sense-impressions and hallucination as perception without sense-impressions. Thus, if I perceive a coat hung over a chair as a burglar in the room, the perception is an illusion, but if I see my mother enter the room when really she is in a distant city, the perception is a hallucination. Aside from the question whether the distinction is absolutely valid or not, it is evident that the presence and absence of sense-stimuli is a physical and not a psychological difference. On the conscious side the two experiences are alike in that they appear to report what actually exists in the objective world. So far as the experience at the moment is concerned, they are not to be differentiated from perception. While illusions are very common occurrences in the normal mind, hallucinations are usually the product of a very seriously disturbed or disordered mind. Hallucinations may be symptoms of insanity; they appear in many cases of religious

[1] "Principles of Psychology," vol. II, p. 86.

ecstasy, or in abnormally prolonged devotion to any cause; they are the result of the use of certain drugs or of bodily disease. The visions of Emanuel Swedenborg were the outcome of religious ecstasy, and those of Joan of Arc of prolonged devotion to a patriotic cause. Continued intemperance in the use of alcoholic drinks may produce the hallucinations of *delirium tremens*, in which the victim is tormented by realistic visions. Chloroform, ether, hashish, and opium will also cause hallucinations. A grewsome description of opium hallucinations may be found in Thomas de Quincey's "Confessions of an English Opium-Eater." Hallucination may appear in hypnotic states and during diseases involving high states of fever.

Hallucinations may be experienced by persons in normal health, but such occurrences are extremely rare. It is said that Raphael had visions of the Madonna, following a prolonged attempt to image her face in order to paint it. Spinello, after painting "The Fall of Lucifer," was reproached by the devil in person for representing him in so hideous a manner.

The following is a typical case of hallucination in a normal individual: "I sat one evening reading, when, on looking up from my book, I distinctly saw a school-friend of mine, to whom I was much attached, standing near the door. I was about to exclaim at the strangeness of her visit, when, to my horror, there were no signs of any one in the room but my mother. I related what I had seen to her, knowing that she could not have seen it, as she was sitting with her back to the door, nor had she heard anything unusual, and she was greatly amused at my scare, suggesting I had read too much or that I had been dreaming."[1]

Dreams oftentimes take on the appearance of reality and are, therefore, forms of hallucinations. The appearance of ghosts, apparitions, spectres, etc., may be pseudo-hallucina-

[1] Quoted from the Proceedings of the Society for Psychical Research, Collection 83, 21.

tions, where there is a feeling that they are not real existences, but mere seeming. They are true hallucinations in cases where they appear to be real.

Hallucination, like perception, may involve only one sense, or several senses. Those of sight and hearing are most common, while tactile hallucinations are relatively infrequent. It is rather difficult to determine whether an olfactory or gustatory experience, without apparent objective stimulation, is wholly subjective, or is due to slight stimuli which we are unable to detect.

The neural basis for hallucinations and illusions is probably the same as in perception. If, for any reason, the "neural pattern," or areas involved in normal perception, become centrally stimulated into full and adequate activity, the conscious result is the same as in perception. Blood pressure in the brain in fever, irritation of the neural tissue resulting from the toxic effect of drugs, or from fatigue following continued thought on one subject, might be the occasion for setting off definite "object patterns" which are the neural basis for the perception of objects. In this way, we might understand how Raphael's continued thought of an imaginary Madonna's face might in the end exhaust the brain areas and break down the normal inertia of the brain cells and bring about the same form of neural activity as the actual presence of the object would cause. The imaginary form would then be experienced as real. It would seem that some form of central stimulation must, in cases of hallucination, reach either a sufficient degree of intensity, or quality, to set off the same brain centres and the same kind of neural action which is required in perception and which is initiated normally by sense-stimulation.

## Perception of Space

The phrase "perception of space" is, in a way, misleading. We do not perceive a definite unitary *thing* which we call *space*, whatever that may be. But, rather, we perceive things or objects which have space relations to each other and to us as perceiving beings. We perceive objects in certain positions, directions, and distances. We speak, however, of the consciousness of these spatial relations as the perception of space (more properly, the perception of spaces). Although the consciousness of space seems very simple, it is nevertheless a very complex experience, and one of the most difficult of all our experiences to analyze.

The first question to appear is: Is the consciousness of space native, or is it acquired? Do we sense space directly as we sense color, odor, taste, pressure, and sound, or is space experience the result of combining sensations into perceptions? There are two opposing theories concerning it. (1) The nativistic theory holds that we possess a native and direct consciousness of space prior to all experience, just as we possess the consciousness of the simple qualities of objects—color, sound, etc. (2) The empiristic, or genetic theory, on the other hand, holds that we have no simple or direct experience of space, that space experiences are wholly acquired, and that they are the result of the synthesis or combination of different sensations. According to this theory the development of space experiences out of the synthesis of sensations, which in themselves possess no space experience, is briefly as follows: In the main the sensations which combine to form space experience are visual, tactile, and movement sensations. They combine in various ways. To take a single case from pressure-sensations and movement-sensations: We may suppose that every point on the skin, from the very first, gives, when stimulated, a slightly different pressure-sensation from every other point. This difference is called "local sign." The differences are not space differences; they are merely qualitative differences. If two points, $A$ and $B$, four inches apart on the forearm, are similarly stimulated, the experience given would be that of two different pressure qualities, local signs $A^1$ and $B^1$. But now, suppose that the other hand moves from point $A$ to point $B$.

Then sensation of the movement from *A* to *B* would be interposed between the consciousness of local sign $A^1$ and local sign $B^1$. The two different pressure-sensations and the movement-sensation would fuse into the unitary perception of the space distance *A–B*. Eye movements may also intervene between the points *A* and *B*. A synthesis of the sensation of a certain amount of eye movement and the two different pressure-sensations would then give the perception of the distance *A–B*. The theory also assumes systems of local sign differences on the surface of the retina and in joint surfaces. From the perception of distance to the perception of surfaces and the perception of the third dimension is a further development, based chiefly upon the sensations of movement and local sign differences in articular sensations.[1]

James[2] stands for a modification of the nativistic theory. He holds that there is a kind of native bigness or "voluminousness," which he calls "extensity," observable in all sensations, and that this is an attribute of all sensations, just as intensity is an attribute. "We call the reverberations of a thunderstorm more voluminous than the squeaking of a slate pencil; a little neuralgic pain, fine as a cobweb, in the face, seems less extensive than the heavy soreness of a boil, or the vast discomfort of a colic or a lumbago." This "voluminousness," or "crude extensity," is the native experience from which space perception develops. Otherwise Professor James's point of view is thoroughly genetic. Voluminousness, or extensity, possesses no spatial order. It is not divided and subdivided into parts, as our developed space world is. The ordering of this primitive space is the result of experience, and, as in the genetic theory, local sign differences play an important part in bringing it about.

The author agrees with those who follow an intermediate

[1] For a more complete statement of the empirical theory of space perception, the student is referred to Wundt's "Outlines of Psychology," third edition, p. 113.

[2] "Principles of Psychology," vol. II, p. 134.

theory between the empiristic and nativistic points of view. Some of our sensations do give an immediate "outspread," or "alongsidedness," of sensory qualities which is a crude spatial awareness. On the other hand, the definite space world, as we now know it, is the result of experience and development. Through various combinations of sensations which synthesize with the vague experience of "spreadoutness," we come to have definite perceptions of position, direction, and distance.

The senses which furnish the original material for space perception are the visual and the cutaneous. Light-stimuli act simultaneously upon a large number of nerve-endings on the retina and arouse an immediate experience of "spreadoutness." Pressure-stimuli upon the surface of the skin likewise affect a large number of pressure spots simultaneously and set up sensations which, although alike, are sufficiently different to be distinguished. To these senses, therefore, objects seem to have a number of simultaneously existing parts[1] which stand outside of each other. The definition and the order of the parts are not immediately given by sensation, but come as the result of further experience. If, for instance, when the eyes are closed, a pair of compass points, 1 mm. apart, are placed upon the skin of the forearm, we perceive, not two distinct points, but a small expanse of pressure. If we separate the compass points gradually, a certain space interval will be reached where they will be felt as two points. They will not, however, be perceived as having a definite direction or distance from each other. One cannot say that one point is to the right or to the left of the other. There is merely the experience of the points as outside or alongside of each other—a vague experience of primitive space.

The olfactory, gustatory, and auditory senses do not, in

[1] The use of the word "part" seems to beg the question. The term does not, however, refer to definable spatial units, but only to the crude extension which we hold is natively given in the retinal and skin sensations.

any tangible way, report objects as being "spread out" or having "alongsidedness," and so the sensations coming from them do not possess the attribute of extension. For instance, in auditory sensations, a number of different sounds fuse together and the resulting experience is not given as made up of parts existing alongside each other. A sound-stimulus does not act upon a number of discriminable different sense surfaces. Therefore, the sound is not experienced as having spatial parts or extension. It should be stated in this connection that some psychologists claim that sound-sensations do possess a native "voluminousness," spatial in its character, as the quotation from James, on a preceding page, testifies. However, this spatial character is not developed. A sound never comes to have, in our highest development of space perception, one part of it spatially set off against another part. We are never able to distinguish, say, an upper right-hand corner of a sound. Sensations of taste and smell, likewise, do not develop into distinct spatial arrangements.

**Development of Space Perception.**—It is evident, when we inquire into the development of space perception, that there are two phases in the breaking up of vague space experiences into perceptions of the definite order and the arrangement of parts which the world of objects shows. (1) Localization—the ordering of the different parts of the skin surface with reference to each other, so that we are able to localize pressure-sensations more or less definitely on the various parts of the skin surfaces. (2) Projection—the projection of sensory qualities to definite parts of a space world beyond the body. These two processes go on at the same time and are reciprocally helpful to each other. We may compare the size of certain objects seen with the size when superimposed upon the skin. Or a seen area of the skin may be compared with the same area as felt.

How do we come to perceive definite positions, directions, and distances upon the skin surface, since they are not given natively? As we have indicated, it takes place through the synthesis of different sensations. The perception of the distance between two points on the skin is the synthesis of the sensation of the movement required to trace the distance between them with the finger or with the eyes, and the pressure-sensations themselves. By moving the hand over the skin surface, we trace lines of directions and set up a series of differing pressure-sensations which combine with the sensations of movements made in tracing the lines. At the same time the eyes may follow the movement, and the sensations arising therefrom may also enter into the perception of the distance on the skin. Likewise, the articular sensations, arising from the slipping of the joint surfaces over each other may form a part of the perception. Localization (or perception of directions and distances) is most refined and accurate on the more mobile parts of the skin surfaces, and most crude and inaccurate where few tracing movements have been made, *e. g.*, on the back. The perception of distance between two points on the skin corresponds to the number of discernible different pressure-sensations that may be aroused between the points. For instance, a distance on the finger-tip of 4 mm. seems much greater than it does on the back of the hand, because the local differences in pressure are greater in number in a given area on the finger-tip than on the back of the hand.

In the same way, distances and directions are determined in the outer world by movement of hand and eye over parts of objects exterior to the body. The greater the intensity of the movement required to trace the contours and distances between points, the greater the perceived space magnitude. Eye movements arouse a series of retinal sensations which are combined with the movement-sensations in the perception of magnitude. If, for instance, we fixate a point *A* on the wall directly in front and then turn the eyes to the right through an angle of 30° to the point *B*, point *A* will trace corresponding lines on the right halves of the retinæ, *i. e.*, the image of point *A* will move from the central position on each retina to the right. The perception of the distance and the direction is formed out of the series of the retinal sensations and the movement-sensations, which are interposed between the terminal retinal sensations.

The original space, given by the eyes, is a vague, formless expanse, without definite directions or distances in it. But, as the sensations of movements of eye and hand, in tracing distances and directions, combine with the sensations aroused on the retina, the objects in the outer world take on form and show a definite, spatial relationship to each other. Cutaneous space and visual space are compared and harmonized by the fact that the same series of movement-sensations (movements of small extent) may measure both spaces, *i. e.*, movements may trace distances felt and distances seen.

**Third Dimension.**—Movement again plays an important part in the perception of the third dimension. The hand may move in all directions—up and down, right and left, to and from the body. For instance, if the hand moves from the face to an object a short distance away, the cutaneous sensations, caused by the contact of the hand with the face and with the object, have interposed between them a series of articular and movement sensations, which may be combined into a perception of depth. The articular and movement sensations acquire a space value in tracing surface magnitudes on the skin. Or the hand may fold upon itself, giving a series of articular sensations, interposed between the cutaneous sensations of the hand open and the hand closed. The articular sensations themselves may combine with movement-sensations, just as cutaneous sensations do, into a perception of distance, so that a movement of the arm may be perceived as having a definite space magnitude. This is possible because of the fact that the articular sensations possess an original spatial character, which becomes ordered into definite space perceptions through combinations with sensations of muscular tension.

Whether the sense of vision can give an original experience of the third dimension or not is a question which has been much discussed in psychology, since the time of Berkeley.[1] He thought that the visual estimate of the third dimension is "an act of judgment, grounded on experience, rather than of sense," for, he said, "distance being a line directly endwise to the eye, it projects only one point on the fund of the eye, which point remains invariably the same, whether the distance be longer or shorter." Berkeley called attention to the fact that, in judging distance in the third dimension, we converge the eyes more for nearer objects than for the farther objects. The degree of convergence gives rise to eye-movement sensations, which act as cues to the judgment of distance.

Berkeley was right in asserting that the perception of the third dimension is not a simple sense experience, but a very complex experience, into which sensory factors from both eyes enter. In the first place, visual perception involves two retinal images of every object perceived. If the images fall upon corresponding parts of the retinæ, the object is perceived as single; if they fall upon non-corresponding parts, it is seen as double. The fixation of an object brings the two images upon corresponding areas of the retinæ, while images of objects nearer and farther away than the fixation-point fall upon non-corresponding areas. The result is that objects fixated are seen single, while objects which are nearer and farther away than the object fixated are seen double, if they are attended to sharply.

Hold up a pencil in front of the eyes, with the blunt end nearer and about eight inches distant, and the sharpened end pointing directly away from the eyes. (The experiment will succeed more readily if the pencil is held by means of a pin, inserted at its middle point.) Fixate the nearer end and two pencils are seen, joining at the point fixated. Fixate the farther end and two pencils are seen, joining at their farther

[1] Berkeley: "Essay Toward a New Theory of Vision," 1709. For discussion, see James: "Principles of Psychology," vol. II, p. 212.

ends, the right pencil extending toward the right eye and the left pencil toward the left eye. Fixate the middle point of the pencil and the two pencils are seen crossing each other at that point. Now, look at the pencil without attempting to fixate any one point. It appears as a single object.

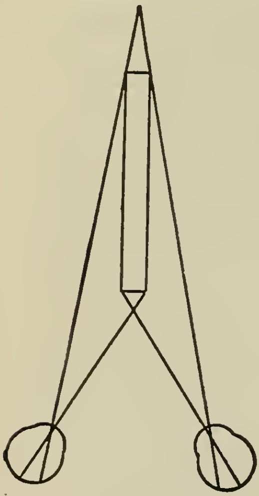


Fig. 66.—Diagram to show the different view of the pencil for each eye. The right eye gets an image of the pencil on its right side; the left eye gets an image of its left side. The images are disparate images.

It is evident that when the pencil is seen as a single object the two disparate images fuse, so that the result is a single percept, but a percept which includes the experience of the object as solid (third dimension). Careful observation will show that, as the fixation-point changes, the disparate images fuse at the point of fixation. In the normal perception of objects the eyes are constantly moving over them, now fixating one point and now another. These different views are synthesized into a single percept, including the muscular sensations of convergence and divergence, which act as a cue to the distances from the eyes to the different parts of the object.

The ordinary stereoscope produces a marked perception of the third dimension by causing two flat but disparate views of the same object to fall upon corresponding parts of the retinæ. The stereoscope, therefore, brings about artificially the natural eye conditions, which are present in the normal perceptions of objects having the third dimension. The stereoscope views are taken with a double camera, so arranged that two views of an object or scene are taken—one corresponding to the view that the right eye gets of the object and one corresponding to the view that the left eye gets of it. When they are placed in the stereoscope, the right view is presented to the right eye and the left view to the left eye.

The two views then fuse into a single picture, possessing the third dimension. If two pictures exactly alike, *i. e.*, having no binocular disparity, are placed in the stereoscope, the perception of the third dimension does not take place.

There are many acquired aids to the perception of distances in the third dimension, effective because of past associations formed in our experience with things at different distances away from us. Some of the most important are:

*Sensations of Convergence and Accommodation.*—The eyes converge more for near objects than they do for far objects and the lens of the eye changes its curvature for objects at different distances. The varying intensities of the sensations arising from these eye movements become associated with various distances and so become suggestions of them. For distances greater than one hundred feet, sensations of accommodation and convergence are of too low a degree of intensity to be used as cues of distances.

*Size of the Retinal Image* (*linear perspective*).—The farther away a given object is from the retina, the smaller the retinal image. The changes in the size of the image are not interpreted as changes in the size of the object, but rather as changes in distance of the object from the eyes. If we know the size of an object, we can judge its distance by the size of the retinal image.

*Aerial Perspective.*—Distinctness of outline of objects is associated with nearness and indistinctness with distance. Also, distant objects show a different color, due to the effect of the atmosphere. The distant hills and mountain ranges are tinged with purple. The green of woods and field becomes bluish, as they stretch away in the distance. In the clear atmosphere of the mountains the distinctness of distant objects causes marked underestimation of these distances by those unused to such conditions. Quite a contrary effect is produced if objects are seen through a fog or a very hazy atmosphere. The dimming of outline causes the objects to appear unusually large, "to loom up," so to speak. Since dimness is the sign of distance, the objects are perceived as farther away than they are. They therefore must appear larger.

*Light and Shadow.*—Objects having projecting parts, or objects in relief, show a characteristic distribution of light and shadow, determined by the source of light. More distant parts are in shadow. Flat drawings may therefore be made to suggest the third dimension by proper shading. A cameo will appear as an intaglio if the source of light is below rather than above.

*Angular Perspective.*—The form of a known angle suggests the distance from the eye to the surface bounded by the angle. The right angle of the top of the table changes its apparent form as it changes its distance from the eye. The apparent form of the angle is a cue to its distance.

*Interposition.*—Near objects cover or cut off farther objects. We perceive the porch column to be nearer than the part of the house that it cuts off. We, therefore, perceive the house as standing behind it.

*Parallax.*—If the eyes are fixed upon some object and the head is moved laterally, say to the right, nearer objects appear to move to the left and objects beyond the fixation-point appear to move to the right. If the objects are very near or very far away, the apparent displacement is large. If the objects are nearer the fixation-point, the displacement is small. This parallactic displacement becomes an indication of the relative distances of objects.

**Space Errors and Illusions.**—We have already referred to the fact of disparity of space perception between the different senses, and also in the same sense. The cavity of a newly extracted tooth seems much larger to the tip of the tongue than it does to the finger-tip, or to the eyes when viewed in a mirror. If the points of a compass, three-fourths of an inch apart, are pressed against the face, the distance between them will feel greater, if one point is above and the other below the mouth, than it does when they touch the cheek.

Filled space extent seems larger than unfilled, when both are applied to adjacent parts of the skin at the same time, but if the space extents are applied successively to the same area, unfilled space seems larger.

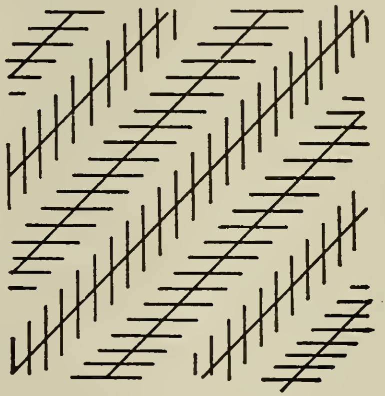
The student may test the truth of this statement with two visiting cards of the same length. Notch the edge of one so that it will have saw-teeth three-eighths of an inch apart. Then cut the other card so that only two teeth appear, one at each extremity. Close the eyes and have someone press the two cards against adjacent parts of the skin. Compare their relative lengths. Apply the cards alternately to the same area and compare their apparent lengths.

The larger number of space illusions are visual. Vertical distances are perceived as greater than equal horizontal distances. Place two points vertically, one above the other, on a sheet of paper. Look steadily at the two points, and then locate a point to the right of the lower one, so that it appears to mark off a distance equal to the distance between the vertical points. Compare the distances. The horizontal distance will appear to be larger. Compare the vertical and horizontal lines in Figure 67. Which are the longer?

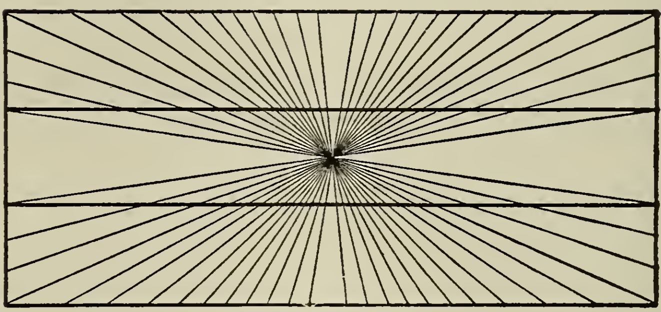
Fig. 67.

The upper half of a vertical line is overestimated in comparison with the lower half. Divide a vertical line in halves so that the upper and lower halves appear equal. Measure them. Select the letter "s" or the figure "8," on a page of printed matter, and compare the upper and the lower halves of each, as to their relative sizes. Turn the page upside down and compare them.

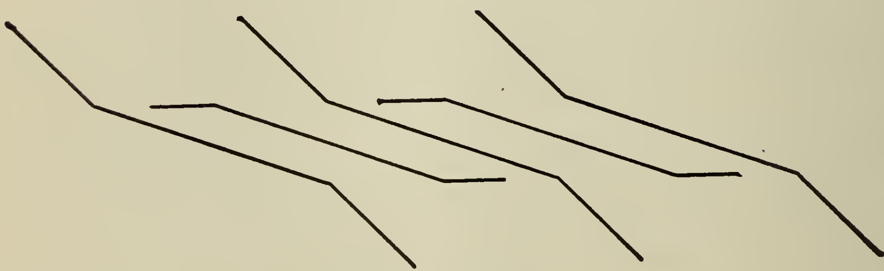
Note the following illusions and try to explain them.



(*a*) Zöllner figure.



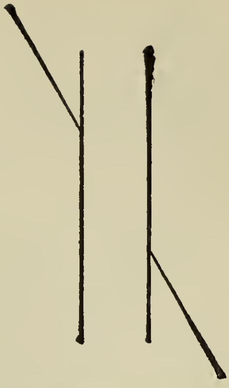
(*b*) Hering Figure.



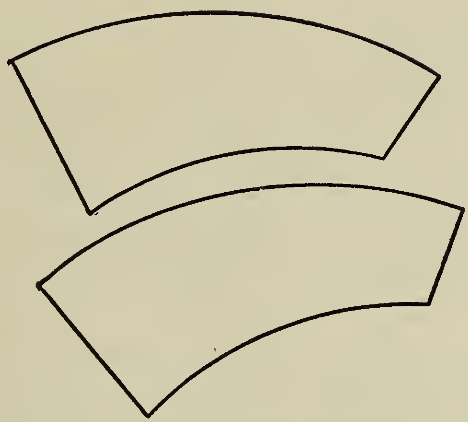
(*c*) Lipps parallels.

Fig. 68.—The lines in Zöllner's, Hering's, and Lipps's figures are parallel. The lower arc in the Müller-Lyer circle is an extension of the larger arc.

(*d*) Müller-Lyer circle.



(*e*) Poggendorff figure.



(*f*) Jastrow illusion of area.

Fig. 68. (Con.)—In the Poggendorff figure the lower oblique line is an extension of the upper oblique line. The two areas in Jastrow's illusion of area are equal.

One of the most interesting space illusions is the Müller-Lyer illusion, the typical form of which is represented in Figure 69.

Many explanations of this illusion have been offered. It has been suggested that the overestimation of the left-hand line and the underestimation of the right-hand line are due to the different eye movements induced when looking at the lines. The arrow-heads, enclosing the line on the right, check eye movements before they reach the extremities of the lines. On the other hand, the oblique lines on the left side of the figure lead the eye out beyond the extremities of the line. Since the amount of effort made in tracing a

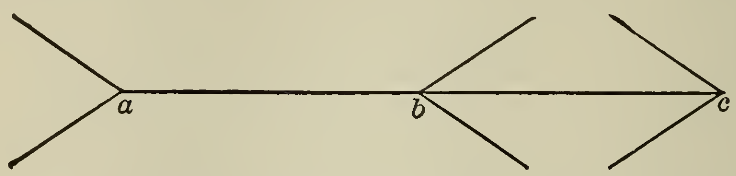



FIG. 69.—Müller-Lyer illusion.

line will affect the judgment of the length of the line, the left-hand line is perceived as the longer.

The eye-movement theory may be applied to most of the other illusions. It is claimed that movements induced by perpendicular lines require more effort than movements induced by horizontal lines. Hence, perpendicular lines seem longer than horizontal lines of the same actual length. In the Müller-Lyer circle, it is supposed, according to the eye-movement theory, that the eyes, in tracing the circle, tend to move outward from the extremities of the upper arc and so pass below the lower arc, making it appear too far toward the centre of the circle. Likewise, Jastrow's illusion of area might be explained as due to eye movement. The eye, in passing over the figures, is inclined to trace the proximate parts of the figures. The two lines that lie nearest together attract the eyes and initiate movements over them. Hence, a shorter movement for the upper figure and a longer movement for the lower figure is the basis for the judgment of the areas of the figures.

Other theories also have been proposed for these illusions. The perspective theory assumes that the simple lines in these drawings indicate the third dimension. For instance, the oblique lines in the Müller-Lyer figure suggest (subconsciously) perspective distance. The oblique lines, forming the arrow-heads, appear nearer where they join the horizontal lines. The oblique lines, forming the feather-ends of the figure, seem farthest away where they join the horizontal line. Hence, the right-hand line appears nearer and the left-hand line farther away in perspective. The nearer right-hand line must then be judged shorter and the farther left-hand line longer, since their retinal images are of the same length. Vertical lines, also, according to the theory, suggest the third dimension and are seen in perspective. They are therefore foreshortened and overestimated, when compared with horizontal lines.

The dynamic theory of Lipps holds that the ideas suggested by figures affect the perception of the figures. Thus a slender spire suggests an upward force, which suggestion enters into the perception of the spire itself; hence, the effect of Gothic architecture. In the Müller-Lyer figure the right-hand side of the figure suggests the idea of being limited, restrained, and cramped, while the left part suggests freedom, scope, and room for movement. These ideas affect the perception.

The confusion theory of space illusions is based upon our tendency to confuse a part of a figure with the whole of it, or upon our habit of perceiving figures as wholes or units and not as parts. Thus, in the Müller-Lyer figure, we are led by this tendency to judge the distances between the arrow-heads as a whole, rather than to judge the distance between the ends of the line, or points of the arrow-heads.

There are other theories offered for the explanation of space errors and illusions, but they are modifications of those just described. It seems probable that no one theory can account for all the illusions. Some of the illusions may be due to many different influences. Perception, as we have seen, is a highly complex and synthetic process. Past experiences and surrounding stimuli may be variously combined in the perception of any given object; hence, the many theories offered to explain the falsifications of perceptions.

The preceding theories of illusory space perceptions significantly fall into two classes:

1. Peripheral theories, or those which attempt to explain space illusion as due to simultaneous sensory factors. Such is the eye-movement theory.

2. Central theories, or those which undertake to explain illusory space perception upon the ground of past experiences. Old habits, ideas, and revived images modify and contort the actual sensations aroused by line and figure.

We cannot arbitrarily decide between them. In fact, we are inclined to believe that both peripheral and central factors enter into our perception of space. Especially so, since we have found that a large part of space experiences is acquired upon the basis of a very crude native endowment. Manifold elements, both native and acquired, have been worked into our space consciousness. No one theory, therefore, can account for the various influences which may be brought to bear upon the perception of objects in space.

**Localization and Projection of Auditory Sensations.**— Sounds are localized more or less definitely, both in the direction and distance from which they appear to rise. The localization and projection of auditory sensation does not signify that sounds themselves possess the attribute of spatial extension, but that they are referred to certain positions in the extended space world of vision, movement, and touch.

The accuracy of the localization of direction of sounds varies for the different positions which the sound-stimulus occupies with reference to the two ears. Sounds, coming from any position in the extended median plane of the head, are poorly localized. One cannot tell whether the sound comes from before, above, or behind the head. Sounds which come from positions outside of the median plane, to the right or the left of the head, are located fairly accurately. The explanation seems to lie in the fact that the intensities of a sound are the same for each ear, when the stimulus is in the median plane. But when the stimulus is outside the median plane, it is nearer one ear than the other, and so the intensity of the sound is greater for the nearer ear than it is for the farther ear. The relative intensities of a sound in the two ears would seem, then, to be a cue to the direction of the sound.

This is probably a sufficient explanation for the localization of sounds, coming from near points. But in case the sound comes from a distant point, the difference in the distances to the ears is relatively so small that the resulting intensities of the sound are practically equal for the two ears. The ability to localize a distant sound, whose intensities are not sufficiently different to be valuable as an indication of direction, has not yet found a satisfactory explanation. More and Fry[1] suggest that the phase differences of sound-waves entering the ears may serve as a basis for distinguishing the direction of a sound. But this would not account for the fact that persons deaf in one ear are able to locate the direction of auditory impressions. Complex sounds, the human voice, musical tones containing many partial tones are located more easily and accurately than simple tones. It seems probable that the head may cast sound shadows, which affect the quality of a complex sound for the ear on the opposite side from its source. The higher partial tones with short wave-lengths would be affected more by the intervening head than the lower tones with longer wave-lengths. In this case the different qualities of complex sounds for the two ears would act as an indication of direction. Even in cases of persons deaf in one ear, the shape of the shell of the outer ear may affect the quality of a complex tone, in accordance with the direction. Persons with one ear only are unable to locate accurately pure or simple tones.

The distance from which a complex sound comes to the ear also affects its quality or timbre. The weaker partials

[1] Experiments made at the University of Cincinnati in 1902, but not published until 1907, *Phil. Mag.*, April, 1907. Lord Rayleigh was led to the same conclusion by somewhat different experimental data. For a more thorough discussion see Myers and Wilson, *British Journal of Psychology*, 1908, II, 363.

become less intense the greater the distance. They may drop out altogether at certain distances. The changing quality of a complex sound may, then, be the sign of its distance. Pure tones are located with much more difficulty than composite clangs and noises.

Associations built up in past experience also play an important part in judging the distances of sounds. After we have become acquainted with a certain sound, the intensity with which it reaches the ear is an index of its distance.

## Perception of Time

There is no perception of pure time. The perception of time is involved in the perception of objects which appear to us to have temporal continuation (prolonged existence). Genetically, the experience of an object as a continued existence is derived from the original and unanalyzable experience of sense-impressions, possessing temporal extension. Every sense-impression begins, rises to its full intensity, and then wanes, thus giving a time-span, which is immediately apprehended. It is conceivable that even if an object existed only long enough to give a single, instantaneous impression and then disappeared completely, it would leave a time experience because of the rise, development, and waning phases of the impression itself. Just as objects are perceived as having co-existing and extended parts (spatial spreadoutness), they are also perceived as having a temporal attribute.

There is, however, a difference of opinion among psychologists concerning the original experience of time. We find, as we did in space perception, two opposing theories of time perception. The empiricists hold that there is no native and unlearned time experience—that time perception is gradually acquired out of sense experiences that are in themselves timeless. For instance, suppose a series of tactual sensations are set up on the back of the hand by tapping it with a pencil point. The tactual sensations themselves cannot, according to the empirical theory, give experience of time.

But there arises between any two successive taps an experience of expectancy, a waiting for the next tap. The intensity of this expectancy increases until the arrival of the expected tap, when it wanes. So, between the successive taps, there is a gradually increasing and suddenly ending expectancy. The fusion of these tactile and expectancy experiences gives the perception of a time-expanse. Organic sensations (breathing, muscular strain, etc.) may also be interposed between other sensations and combine with them into the perception of time. In short, the empirical theory holds that the mind gets time out of the combination of different sensations, not that sense experiences themselves give time to the mind.

On the other hand, the nativists hold that time is an original attribute of all conscious states—that it is a part of our mental content from the beginning. The author agrees with the nativists in affirming that an original temporal attribute attaches to all sensations, and with the empiricists in maintaining that developed time perceptions are the result of experience and come about through the synthesis of elementary sense experiences.

**Elements of Time Perception.**—The native and primary experiences of time are (1) *simple duration* and (2) *succession.* Simple duration arises out of the fact already referred to, that every sense-impression begins, rises to fulness, and ends. These phases are never separated—never given as discrete parts of the time interval; but they are always bound together in a single moment. Each sense-impression possesses a brief time breadth—a simple "now"—the simplest time experiences we have. The content of this simple moment is the differing intensive phases through which a sense-impression passes from its beginning to its close.

The normal length of time required for a sense-impression to mature, or develop in consciousness, varies somewhat with the nature of the stimulus and also with the sense stimulated. For ordinary impression, it is about one-half second. If a series of sounds are given one-half second apart, each sound duration seems adequate, but if the sounds are nearer together, say one-fourth second apart, the duration of each single sound seems cramped. If the sounds are further apart than one-half second, the duration seems too long. In such cases, there is a tendency to fill in with other sense material —usually sensations of muscular strain, respiration, and organic changes.

Experiences of succession arise out of our native ability to discriminate between different sensory impressions. We apprehend a series of sense-impressions as a succession of sensory "nows."

By means of the synthetic processes of perception, the "nows"—the elements of time experience—are combined into larger and more complex units. Several sense-impressions with their simple durations may be combined into a single perception. For instance, I may perceive three or more notes on the piano, sounded in succession, as a single time expanse. A number of cutaneous sensations, following each other, may also be perceived as a single "now." The "now," in these cases, is a larger and more complex "now" than the simple "nows" of sensation. It is the result of the synthesis of sensory bits of time, or simple durations, into a present moment which we call the psychical present.

**The Psychical Present.**—The psychical present[1] is that section of the time expanse which we feel to be presented *now.* It varies in length from about one-half second to six seconds. Longer periods will not hold together, as a unit, but tend to break up into component parts. The content of the psychical present is also variable. If we listen to the strokes of the metronome (120 strokes a minute), it is possible to combine two, three, four, or six strokes into a single perception. So with other sensory impressions. A varying number of them may be synthesized into the psychical present.

The number of events, which we experience in any present moment is determined by our adaptive reactions. Whatever

[1] Sometimes termed the "specious present."

corresponds to a single reaction is unified into a present moment. If I count singly the metronome strokes, then each stroke occupies the present moment. If I count them by threes, then three strokes occupy the present moment. This is in harmony with the principle which we found to be true in the perception of objects: viz., that we perceive as combined in a single object that group of sensory impressions to which we make a single reaction.

**Sensory Material of Time Perceptions.**—While all the senses furnish material for time perception, the most prominent content is that furnished by the auditory, kinæsthetic, and tactual sensations. The rhythmic movement sensations in organic processes (breathing and heart action) may fill in the interval between two auditory or tactual sensations and combine with them into a single moment. As one listens intently to the strokes of the metronome more than a second apart, the time between them is filled in and measured by sensations of respiration and muscular strain set up by the bodily attitude of listening. The duration of the interval is judged by the amount of change in the respiratory and strain sensations. Genetically, the most original time experiences are furnished by the muscular, tactual, and the organic sensations. These sensations are constantly present and form a temporal continuum against which outer events are projected. Events which are perceived as taking place outside of the body are measured by the changes in the bodily processes. Organic changes and movements and pressures are probably noted before the changes which take place in the outer world (sounds, lights, etc.).

**The Psychical Present and the Logical Present.**—The psychical present must not be confused with the present of logical analysis—the logical present. While the former has an actually experienced duration, the logical present can be shown to have no duration. It is simply a point, "a knife edge" dividing the past from the future. Suppose we grant to it a very brief duration, then this duration, however short, can be analyzed logically into a part that has just passed and a part that is yet to come with the present separating them. Any duration, whatsoever, which is conceived to belong to the present may, therefore, be analyzed into past and future, leaving no present duration. If, however, we realize that the logical present is theoretical and not an actually experienced moment of time, it will present no difficulties. The psychological present is an actually experienced duration.

**The Past and the Future.**—Only the present moment can be perceived. The past and the future are mental constructions which we fill out with imaginary content. We can thus construct a time continuum extending in two directions from the actually perceived present. Part of the past, our own, may be represented in memory, but the remote past, the past of the ages, which we contemplate, is the result of constructive imagination. The future is also ideally constructed. Its content is filled in from the actually experienced events of the past and the present. Future events have a representation in the present moment content, in so far as we represent them ideally and anticipate or await their occurrence. But since we can represent future events only in terms of past events, the future is conditioned by the past. It has been said that "the future is not in front of us, but rolls up from behind us."

All time is regarded as belonging to one unlimited time. But we are unable to form any adequate conception of an unlimited time expanse. We cannot, for instance, conceive of a past that stretches back without a beginning, or a future that has no end. Neither can we conceive of a past with a beginning, or a future with an end. Such attempted conceptions, however, lead directly into the realm of metaphysics.

**The Measure of Time.**—For all our practical purposes, we measure time objectively by the regular movement of the sun and stars. Clocks and watches, which divide time into seconds, minutes, hours, days, etc., mark off the course of the movements and changes in the heavenly bodies. Such measures are purely objective. On the other hand, the psychological time, the time which we experience is subjectively measured by the changes in consciousness—*i. e.*, by the number of sensations and ideas which occupy the attention. The hour or day seems long or short, according as it is filled with few or many conscious changes. The so-called objective time and the psychological time do not, therefore, correspond. While objective time has an absolute standard of measure in the physical happenings (movements of sun and stars), subjective or experienced time has no such standard. Of two objectively equal periods, one may be experienced as much longer than the other. The hour which seems short to me may seem very long to my companion.

When deprived of any objective measure of time, our estimation of the length of intervals is based upon changes in consciousness itself. The conscious material, which fills the time intervals, varies with the length of the interval. Very short intervals, less than one-half second, are filled by the changes through which a single sense-impression passes as it rises and wanes in consciousness. Intervals from one-half second to four seconds are filled with the muscular strain in eye, ear, head, neck, and other parts of the body, and intervals longer than four seconds by the muscular sensations of inspiration and expiration.

Short periods of time (less than .75 seconds) seem longer than they are objectively, *i. e.*, they are overestimated; long intervals seem shorter than they are; *i. e.*, they are underestimated. Between the shorter and longer intervals there is a duration which we estimate with more accuracy than any other. This is known as the indifference period. Its absolute length is about .75 seconds.

Many authorities call attention to the difference in our estimation of the length of filled and empty time. There is, however, no such thing as empty time; for all time intervals are filled with some kind of conscious change. What is meant by empty time is a time interval which has in it no clear sensations aroused by outer stimuli, *i. e.*, stimuli outside of the body. Such intervals are really filled by kinæsthetic and organic sensations coming from bodily changes. The difference between the so-called empty time and filled time is the difference between time filled with sensations of bodily changes and time filled with sensations of outer changes.

Short intervals (less than two seconds) seem longer, when filled with sensations of outer changes than when empty, *i. e.*, when filled with kinæsthetic[1] and organic sensations. In judging intervals longer than two seconds the estimation of their length is reversed. Such intervals, when filled with interesting events, seem short when compared with equal intervals not so filled. When we are busily occupied, time flies; when we are not occupied, time drags. An hour filled with happenings, activities, or ideas passes before we know it, while an hour with few changes in it seems never-ending.

The estimation of remembered time periods presents a paradox. For time that seems short in passing seems long when we review it in memory; and time that seems long in passing seems short in memory. In remembering a time period, we estimate its length by the number of events that have been crowded into it. Consequently, past intervals of time that were filled with events seem long, while empty intervals seem short in retrospect.

As we grow older the time seems to pass more quickly than it does in youth. This is especially true of the longer periods of time—the year, month, and week. To the child, the year seems much longer than it does to the adult, but there probably is no appreciable difference in the shorter intervals—the minute and the second. The youth eagerly looks forward to the future, impatient for all that it holds for him. The months and years stand between him and his goal, and he therefore notes their course more keenly. For

[1] When organic sensations become unusually intense, the time they occupy appears longer.

that reason the mature man, to whom most of life's experiences have already come, and who is beginning to look backward as well as forward, regards the passing time with less solicitude. He is not interested, as the youth is, in the mere passing of time. The mental attitude of waiting, of expecting some new experience, makes us aware of the extent of time. When the attention is directed to the flow of time itself, its seeming duration is lengthened.

# CHAPTER X

## MEMORY

**The Image.**—In sensation and perception, consciousness is awakened only when external objects are presented to the sense-organs. We may, therefore, refer to sensation and perception as *presentative* consciousness—consciousness prompted and directed by external objects. But experiences of objects which we have once had may be retained and revived or re-experienced without the presence of the object itself, *i. e.*, we may be conscious of objects not present to the senses. I may now have a mental picture of an object which I saw yesterday, although the object is not present. Such consciousness we may call *re-presentative* consciousness —consciousness internally prompted and directed. The form of consciousness in which the sensory content of past experiences is revived is known as *imagination*. In my "mind's eye" I can see the house I visited last week, and hear the voices of its inmates. These experiences are mental images. Mental images are conditioned upon previous perceptual experience. The person born deaf cannot have auditory images. In short, without the original sensory experiences no reproductive consciousness is possible. On the other hand, any actual sensory experience may be re-presented by means of these mental images.

The physiological basis of mental images rests (1) in the retention of the modifications made upon the brain by previous experience and (2) in the recurrence of the same or similar nerve processes in the brain centres. The activity of the sense-organs, however, is not present. We may suppose that the neural process of perception produces some modification of the nervous substance in the brain, and that the retention of this modification is the condition for the representation of previous experience. When we speak, as we often do, of mental experience being retained and reproduced it must be understood that a neural basis is always involved. It is often advantageous to speak of past experiences as stored in the mind and retained there until they are again revived, but this is only a convenient fiction of scientific psychology. When we treat of the association of images and ideas we shall continue to speak of ideas becoming associated together, and of the tendency of one idea to reproduce another by virtue of the associative links established between them. However, we take it for granted that the real link between ideas, and between past perceptions and present reproduced images, is the modifications retained in the brain centres.

There has been a great deal of discussion as to whether the image and the perception have their basis in the same or in different brain centres. The question cannot be said to be absolutely settled, but it seems very probable that the image and the perception of an object involve the same brain centre. It is, however, necessary to assume that the nervous activities in the cortical centre differ slightly, because we are able to distinguish the difference between the perception and the image of an object. Since the conscious states are different, the brain processes which cause them must be different.

It is customary to point out as the difference between perceptions and images the fact that the former are externally aroused, while the latter are aroused by inner brain processes. While this is true, it is not a difference in the nature of the experiences themselves. However, the image does differ from perception psychologically. Careful observation reveals the fact that images are less *vivid*, less *distinct*, less *stable*, and less *coercive*. Images do not stand out as perceptions do. They are less detailed, more fragmentary, and more fickle or vacillating than perceptions. Neither do they hold or command attention or move to action as perceptions do. All this is evident if one will compare the mental image of a beautiful landscape which he has seen with the actual perception of a similar scene.

Now, the image is the basis of two forms of re-presentative mental life—*memory* and *imagination*. Memory is not only a re-presentation of our past experiences, but it involves recognition of them as our own former experiences. Imagination, on the other hand, is either (1), the mere revival of sensory experience without definite reference to any particular past event or object; or (2), the mental construction of events or objects which have never really taken place in our own experience. The latter is the popular meaning of imagination. In many cases past perceptual experiences are revived without any recognition of them as actually having been a part of our experience. For instance, I may be thinking of the currency bill, as pending in Congress, when a fairly correct and definite mental image of a silver dollar arises in my mind. In this case the image is evidently a revival of past perceptions of silver dollars, but I am not aware of it as such. Simple revival is known as *reproductive imagination*. Reproductive imagination is an essential stage in memory. Or, perhaps, it would be better to call it the basis of memory. However, it does not constitute a complete memory act, as we shall see.

**Definition of Memory.**—Memory is the retention, recall, and recognition of past experiences. Since retention and recall are the stages of reproductive imagination, we may say that memory is reproductive imagination plus recognition. Locke defined memory "as the power of the mind to revive perceptions which it has once had, with the additional perception annexed to them that it has had them before." Practically the same definition is given by James: "Memory proper is the knowledge of an event or fact, of which meantime we have not been thinking, with the additional consciousness that we have thought or experienced it before." But before we can have "knowledge of an event or fact" it must be *retained* and recalled. There are then three steps or stages in a memory act:

1. Retention.
2. Recall.
3. Recognition.

(1) *Retention.* We have already seen that the retention of original impressions is based upon the modifications made upon brain tissue, and preserved in brain centres. Some of the earlier psychologists thought that mental impressions were preserved in the "mind" as mental states, and that therefore they were always in existence "in the storehouse of memory" even when we are not conscious of them. There is no scientific basis for such a hypothesis. An idea as a conscious fact exists only when the brain centres corresponding to it are active. We must therefore think of retention in terms of brain modifications. It is not the mind but the nervous system that retains our experiences. There is considerable difference among individuals in ability to retain impressions. Some brains retain modifications made upon them as wax retains the impression of the seal, other brains lose their modifications almost as soon as they are made. Between these two extremes lie many intermediate degrees of ability to retain impressions. The normal brain has thousands of modifications wrought upon its tissue, and these modifications determine the nature of its activity. They represent the past experiences of the individual. Some of the experiences have cut deep into the tissue, and will never be effaced; others have only touched the surface, leaving very little trace behind them.

(2) *Recall.* The passage of a particular sensory impulse through a brain centre leaves the centre capable of and liable to react in the same way again, even when the external stimulus is not present. When this inner neural activity takes place again we have the phenomenon of recall. It is reasonable to suppose that a given brain centre cannot arouse itself to activity, but that it acts only when other centres,

already active, discharge impulses into the given centre. This supposition is backed up by the facts of mental re-presentation. Whenever a particular event, or object, is recalled, observation will show that we are reminded of the event or object by some thought or presentation already in consciousness. We recall past events by means of their associates. Any thought, percept, or image already in the mind tends to arouse the experiences which have been associated with it, because our experiences are chained together by association. Given any single link in the chain, we are able, in reproductive consciousness, to repass to the other links by virtue of these associative connections. What is the real explanation of the fact that we recall our experiences in the general order and scheme in which they took place? Why is it that the thought of $2 \times 4$ is followed by the thought of 8? Why does the sight of my friend's dog bring up the mental image of my friend himself? The usual answer that such sequences of conscious states are determined by the law of association, only restates, or rather generalizes, the facts as we know them. It does not explain them. The explanation is to be found in the nature of the nervous connection between the cortical areas involved in the original experiences. We may suppose that if the neural activity in a given brain centre is followed or accompanied by the stimulation of another centre, that the pathway between the centres is opened and there is a passage of nervous energy over this pathway. The two centres are in a condition of heightened neural activity, and are discharging their energy. Under such conditions it is reasonable to suppose that the energy of the one passes to the other, establishing a pathway between the centres. Then, according to the law of neural habit (that nervous impulses tend to follow the pathways that they have made on former occasions), we are able to get a general idea of what happens in the brain when the sight of my friend's dog is followed by the revived image of my friend himself.

In psychological terms we may say that the process of recall follows the law of habit—that in any series of revived experiences each is followed by one of its former associates, and any part of a system of thought tends to reinstate other parts of it. But since a single mental experience may have had a number of different associates, what determines which one will be recalled? Evidently, a given mental state will recall the associate that is most closely connected with it, or, to return to neural terms, recall will follow the most permeable pathways. The permeability of neural pathways, or the closeness of association between mental states, is determined by any one, or several, of the following factors: (1) Recency, (2) frequency, (3) vividness of associated experiences, (4) dominant system of thought or the conscious context at the time of recall, and (5) the plan or purpose present in the mind.

Often it is the most recent associate which is revived. At other times it may be the most frequent associate, and at still other times the vividness of an associated experience may win the day for it. It may happen that recency and frequency, or recency and vividness, may work together to recall an experience. Illustrations of these cases may be easily supplied by the student. Usually the reproductive tendency of our thoughts is determined by the nature of consciousness uppermost at the time—by the context. If one is reading or thinking about politics, the word "party" brings up the thought of Republican or Democratic. On the other hand, if the topic of thought is set upon one's social obligations, the word "party" may bring up the thought of the dinner-party that he should give to repay his social debts. In reading or listening to a lecture it is the context that determines which of the many meanings of a word is to be recalled. Recall is also directed very largely by the purpose or plan which we have in mind. We recall that which serves the end in view. If our purpose is to remember the names of the Presidents of the United States, Washington is followed by Adams, rather than by Mount Vernon or the Delaware.

It is plain that the context of thought and purpose usually work together. In practical memory the process of recall is selective. If a given mental state always recalled all its former associates impartially, memory would become a burden instead of an aid in thinking. As a matter of fact, only those associates which are more or less appropriate to the present purpose of the mind are recalled. The general direction which recall takes is, therefore, determined by the topic of thought which we select.

This form of recall, which is guided and controlled by a definite purpose, has been called *active* or *voluntary recall*, to distinguish it from the aimless reproduction in reverie and day-dreaming. However, we cannot directly will to recall a definite past experience, so that the term voluntary recall is misleading. The most that we can do is to search in the general direction in which we think the desired experience lies, and wait for the associative connections to revive it. In most cases recall takes place directly and immediately. The particular appropriate associative link becomes active the moment the attention is turned in the desired direction. For instance, when I wish to remember the name of the first President of the United States the associative connection between "first President" and "Washington" is direct and immediate. But in some cases the so-called voluntary or active recall is indirect. Suppose I try to remember the name of the bookseller who sold me an old copy of Shakespeare. The thought of this particular copy should bring up directly the name of the bookseller, but it fails to do so. I then review, one after the other, all the other associates, the location of his shop, his personal appearance, the other books I bought of him, but no one of them is successful in reviving his name. I may then try the method of pronouncing the letters of the alphabet, hoping that the sound of the first letter of his name will possess a sufficiently strong reproductive tendency to awaken the name. This is often successful. Thus, under the guidance of purpose we give our attention to the circumstances which we feel are in any way connected with the forgotten name, and these associates do the work for us.

Sometimes recall appears to be spontaneous, *i. e.*, taking place without the aid of associative links. Ideas and images pop into consciousness without any apparent connection. They seem to rise up out of the depths of consciousness by virtue of their own force. Vivid or painful experiences will for days continually appear and reappear. Likewise, a tune will "run in the head" for hours. In some cases these apparently isolated memory fragments have been found to be due to subconscious associations, or to such delicate associative connections that they escape ordinary observation. It is, of course, conceivable that for some time after a brain centre has been stimulated into action the recency of the action leaves it very susceptible to the same kind of activity, so that it springs into action again upon the slightest stimulus, such as changes in blood circulation and pressure, free energy from other active centres, etc. In such cases associative links are not necessary for revival. In the great majority of cases of *spontaneous recall*, associative connections that are hidden from observation are probably responsible for the revival. However, some cases of recall seem to depend upon the strength and vividness of the original impression, rather than upon associative connections. A great misfortune, or a great joy, will recur again and again in consciousness without any association nexus.

(3) *Recognition.* The final stage of a memory process is *recognition.* When a past experience is revived and the revival is accompanied by the consciousness that it has been experienced before, we have memory in its exact sense. The chief subjective mark of recognition is the feeling of familiarity. Whenever we remember an event or object there comes with the sensory content of the event or object the added feeling-content of familiarity. The feeling of familiarity is a subjective sign of the degree of certainty of recog-

nition. If the feeling of familiarity is strong we are certain of the recognition, but if the feeling of familiarity is weak we are doubtful about it. The feeling of familiarity is not, however, absolutely trustworthy. It may accompany a false memory act. It often happens that a witness gives in perfectly good faith erroneous descriptions of events which have in some way acquired a feeling of familiarity, which makes the event real for him. In some cases the feeling of familiarity may be detached from and aroused independently of the event to which it is normally attached. For instance, on visiting a strange place for the first time, the feeling may suddenly come over me that I have been in this place before under the same conditions—have said the same things that I am now saying, etc. This feeling is probably the familiarity feeling that belongs to some former similar experience, which just fails to be recalled itself. The present situation brings up the feeling of familiarity without the rest of the original experience. In other words, it is a case of incomplete memory.

Recognition may be immediate or mediate. Immediate recognition takes place without further recall. The experience recalled is recognized on its own account. On the other hand, mediate recognition does not take place until the associates of the recalled experience are also recalled and made to serve as a guarantee for it.

We often confuse recognition and memory in our everyday thinking. For instance, on meeting a man the second time we may remark that we remember him. We cannot, of course, remember him since he is at the moment present to the senses. What we really mean is that we recognize him. Our recognition on this occasion accompanies the perception of the man, not the revived image of him. Such sensory recognition is probably possible in a stage of development where memory is not yet developed. The child may be able to recognize objects when he sees them, long before he is able to reproduce images of them when absent. Sensory recognition, therefore, appears before memory is possible. Later, when images of former sensory experiences become possible, recognition attaches to them in the same manner as it did formerly when the actual sensory experiences were repeated. Thus, sensory recognition develops into ideational recognition.

The function of recognition in sensory experiences rests in the identification of objects and experiences. It is extremely valuable to us as conscious beings that, after becoming acquainted with the characteristics of an object, we should be able to recognize that object when it appears again. By virtue of this recognition we can then make use of all our previous knowledge about the object. We know what to expect of it, how it will act, etc. We are, therefore, prepared to react to it without going through the process of learning its characteristics again. This we should be obliged to do if we did not recognize it. Thus, the child profits by the recognition of nurse, bottle, ball, etc., because, having learned their characteristics on former occasions, he can by virtue of recognition react more advantageously to them. Sensory recognition (recognition of objects) is really a primitive form of memory—a method of making use of past experiences. Memory proper appears when the reproduced mental image of the object is substituted for the presentation of the object itself.

When the same object has been presented many times, recognition of it as a single former experience tends to drop out. We become perfectly familiar with it, and adjust ourselves to it automatically. The identification of it as a particular former experience is then unnecessary. Likewise, in memory, when the image of an object or event has been repeated many times, recognition becomes less and less prominent and finally disappears, leaving the feeling of familiarity as its representative. For instance, when we first learned that Washington was the first President, or that $4 \times 4 = 16$, our memory of these facts included the identification of each as a definite former experience, when and where and how we learned it. The recognition of the memory image was necessary at first as a guarantee that it re-presented a real experience. But later we accept the mere revival of the image without identification or guarantee other than itself, except the feeling of familiarity which survives from the earlier acts of recognition. Thus, much of our past experience is revived or re-presented without recognition or without being remembered in the strict sense of the term. All that I know and can reproduce of history, arithmetic, geography, etc., and my ability to read and write are the results of former experiences, yet I do not identify my present reproduced thoughts of this knowledge with these former experiences, nor am I aware of them as past content of my experience. I can recall my name, but the chances are that I do not think of it as a former experience. It is merely reproduced, or re-presented, not explicitly recognized. However, the practical result is the same. It is memory with an element which has ceased to be useful dropped out. Reproduction under such conditions is really a stage of re-presentative mental life *beyond* or *above* memory—a stage of re-presentation where recognition is no longer necessary. If we were obliged to identify by recognition all re-presented mental content, even after we become familiar with it, our thinking and acting would not be as expeditious as it is.

However, without recognition in the beginning re-presentative consciousness would be of little value. For it is plain that, unless an image has been at some time certified to as based upon real experience, it can function only as mere fancy. Recognition, then, is an important and necessary phase of memory.

**Organic Memory.**—We often say that we remember how to swim, how to skate, how to play tennis, etc. It is evident that the modifications left behind by former practice and training have been retained by the organism. We can hardly say, however, that such cases involve conscious recall. Where these habits of skill are perfected the organism reacts in the same way in the same situation, without the aid of the conscious recall of former experiences. This form of organic retention has been termed *organic memory* by certain authorities. It is mentioned here in order to differentiate it from memory proper.

**Individual Differences in Memory.**—There is great variation in the character of memory among different individuals. Some have very poor memories, being able to retain and recall only a small part of what they experience. Others have prodigious memories, retaining practically everything they see and hear. Most of us, however, possess memories which lie between the two extremes. It does not follow that unusual ability of memory gives great mental power, or is a sign of great intelligence. Some wonderful memories have been found in idiots.

Our memories are not equally good for all kinds of material. Some have an excellent memory for some things, and a very poor memory for other things. "Many a woman of generally feeble memory can remember every dress she has owned since she was ten years old," says Thorndike. The story is told of a certain chief of criminal records in a large city who knew the histories of the 25,000 criminals (contained on identification cards in the bureau), but who on one occasion could not remember his home telephone number. In many cases memory follows the types of imagination, *i. e.*, some remember best what they see (visual type), others remember best what they hear (auditory type). Pillsbury, the American chess-player, possessed a wonderful visual imagination and memory. Blind Tom, the blind musician, who could remember and reproduce long musical selections after hearing them once, had a very poor memory for other material. Such cases illustrate the fact that we possess not *a memory*, but rather, many memories. One of the most marked differences in the character of memory is furnished by the nature of recall. Some persons have what James calls *desultory memory*—a memory with a marked tendency to recall past experiences only in the order of their original occurrence. Such memories grind out their grists just as they were put into the mill, or, to use another figure, they are like phonographs, reproducing impressions in the same manner that they were received. An excellent illustration of this form of recall is found in Jane Austen's "Emma," quoted by James:[1]

"But where could you hear it?" cried Miss Bates. "Where could you possibly hear it, Mr. Knightley? For it is not five minutes since I received Mrs. Cole's note—no, it cannot be more than five or, at least, ten—for I had got my bonnet and spencer on, just ready to come out—I was only gone down to speak to Patty again about the pork—Jane was standing in the passage—were you not, Jane? For my mother was so afraid that we had not any salting-pan large enough. So I said I would see, and Jane said, 'Shall I go down instead?—for I think you have a little cold and Patty has been washing the kitchen.' 'Oh, my dear,' said I—well, and just then came the note. A Miss Hawkins—that's all I know—a Miss Hawkins, of Bath. But, Mr. Knightley, how could you possibly have heard it? For the very moment Mr. Cole told Mrs. Cole of it, she sat down and wrote to me. A Miss Hawkins——"

The nature of the recall in such a sequence of reproduced experiences is known as "*total recall,*" *i. e.*, every idea acts as a whole in calling up the next idea. The present mental content is not broken up or analyzed. There is, therefore, no selection of, or emphasis placed upon any one part of it. As a result, only those experiences which have been associated with it as a whole are recalled—a superficial way of thinking.

On the other hand, some persons have "*logical memories*" —memories in which recall follows the logical connection of thoughts or experiences. Two things which happen together may not have any vital relationship whatever. Therefore, in the logical mind, they are not put together, and so are not revived together in reproduction. The logical memory is highly selective. It breaks up the present presented situation or thought into its more elemental parts, one of which

[1] "Principles of Psychology," vol. I, p. 571.

acts as a connecting-link in recall. This is known as "*partial recall*," *i. e.*, a part of a thought or situation calls up the next thought in any sequence of mental images. Persons who recall in this way possess the ability to see the subtle and logical connections which exist between things. They attend to the relationships of similarity and identity, and not merely to the superficial fact that two events take place at the same time or successively. To illustrate the difference between total and partial recall: Suppose the sight of the lamp on my desk recalls the shop where I bought it. Here the perception of the lamp as a whole connects with a past associate (total recall). But, suppose the sight of the lamp makes me think of the sun. In this case the connecting-link is not the lamp as a whole but a part of it—its luminosity (partial recall).

We often speak of the memory in which recall takes place without logical connections as *rote memory*. In this case there are no inner relationships between the things recalled. The only connection rests in the fact that they have been experienced together (association by mere contiguity). Notice the difference in the mental connections of the terms of the list of nonsense-syllables: seg-bom-wek-caf-lon-dut-rin-foh-gal-gif, and those in the list of sense-words: teacher-school-pupil-spell-write-read-book-pencil-paper. When trying to remember them the nonsense-syllables are recalled by rote memory, while memory of the sense-words makes use of the logical connections.

In some cases we find very extensive memory of the desultory type. Great masses of material are retained, but the facts may not be properly organized. The result is that, as was the case of Dominie Sampson, "its owner can never lay his hands on any one article at the moment he has occasion for it."[1] The readiness with which a memory recalls what is relevant to a given situation is called its "*serviceableness*" by Stout.

[1] Quoted from "Guy Mannering" (in Stout's "Manual of Psychology," p. 437.)

**The Training of the Memory.**—Retention depends upon the character of the brain tissue—its native tenacity. "This is a physiological quality, given once for all with an individual's organization, and which he can never hope to change."[1] According to James, this native retentiveness cannot be improved by training. While we may grant the truth of this statement, we must not forget that there is another important condition of memory, also mentioned by James, viz., the number and character of brain paths connecting any centre with other centres. In psychological terms, the greater number of appropriate associates a fact has, the oftener it is thought in these connections, and the more vivid the attention given to it, the more easily it will be recalled. This means that, by properly organizing and classifying the material of memory, by repeating it a sufficient number of times, and by carefully attending to the things we wish to retain, the memory for any particular fact or group of facts may be improved.

There is an erroneous popular conception that the memory is something that may be taken out and exercised, as a trainer exercises his horse, and that the exercise of memory in any kind of subject-matter improves it for all kinds. We have touched upon this point before, when we called attention to the fact that we do not have *a memory*, but *memories*. Improvement of the memory for language does not improve the memory for mathematics, except in so far as we learn methods of study and logical organization in the study of the one which can be applied to the study of the other. Improvement in the memory of one kind of material aids in the memory of another kind only in so far as the methods of organizing and learning the different materials overlap.

We may say, then, that mere retentiveness of impressions depends upon the kind of brain tissue one has, but that the power of fixing and recalling any particular impres-

[1] James's "Principles of Psychology," vol. I, p. 664.

sion depends upon the number of associates which we form with it, the frequency with which we review its connection and the degree of attention given to it. Further, all these factors except the native character of the brain are under the control of the individual and, therefore, one may improve the memory for any kind of material by practice. In fact we may say, in general, that any training which causes us to consider facts fully and thoroughly, to associate them logically, to review them from time to time from different points of view, and to connect them with our interests, will improve the memory for such facts.

**Methods of Memorizing.**—The most prominent methods of memorizing are: (1) Repetition, (2) Concentration, (3) Recall, (4) Sectional, (5) Entire. By going over and over again the same material it will with a sufficient number of *repetitions* become fixed in memory, but experiments have proved this method to be wasteful of time. Prolonged and intense *concentration* of the attention is much more efficacious than a mere mechanical repetition. Careful experiments have established the fact that the *method of recall* is the best. This method is more in accord with the actual conditions under which practical memory works. It requires the arousal of the memory material from within just as we recall it in actual memory. This method requires that after one or two impressions from without, the subject then tries to recall the material. If not successful, it is gone over once more, and again attempts are made to recall it. This process is kept up until the material is learned. In this way the most active participation of the learner is called forth. In memorizing a poem, paragraph of prose, or other material, it is a very common practice to use the *sectional method.* The material is divided into small sections and each section learned separately. This, again, has been found wasteful. No division should be made in learning that is not required at the time of reproduction. The *entire method*[1] is more economical and trustworthy. Each

[1] Sometimes called the "global method."

logical unit of whatever material is to be learned should be gone over from beginning to end to get the best results.

With regard to the distribution of time devoted to memorizing any given subject-matter, it has been found uneconomical to force the learning process by continuous repetitions without pause. It is better to give a few minutes each day for a number of days than to concentrate the same time of effort into one day. The total time required is less and the impressions are more firmly fixed when the time for learning is thus distributed than when it is all given at a single sitting without intermission. Fifteen minutes a day for twenty days brings about better results than sixty minutes a day for five days.

The greater the number of appropriate logical connections that are attended to and emphasized in memorizing, the shorter the time of learning and the more permanent the acquisition. Thus, with one subject it required fifty-nine repetitions to learn a series of thirty-six nonsense-words, while a verse of poetry containing thirty-six words required only ten repetitions. Twenty-four hours later he had forgotten 65 per cent of the nonsense-words as against 45 per cent of the poetry. Rational associations were, therefore, much more effective than the mechanical connections of rote memory, both in the acquisition and retention of material.

**Forgetting.**—We have already seen that those things to which we give our attention make the deepest and most lasting impressions. Attention is never evenly divided over the field of our experience. It is concerned with certain portions, while it neglects or slights others. The portions which lie outside the focus of attention impress us less deeply, and are therefore more easily lost. Consequently, forgetting is as normal a function of consciousness as remembering. If we were obliged to carry in memory all the events of our experience we should find ourselves swamped by a great mass of irrelevant and insignificant details.

But, forgetfulness normally extends to the experiences which have enjoyed the fulness of attention. Although it may cause us great inconvenience at times, there are certain advantages in being freed from the burden of the past. The factors which lead to such lapses of memory are very numerous and refuse to be placed under any one principle. It is generally and popularly believed that disagreeable and painful experiences are not forgotten. This, however, is not true. There is a marked tendency to forget the disagreeable. The things that we do not like—our past pains and unpleasant experiences—drop into the background of consciousness sooner than the agreeable experiences. Usually we forget quickly that which we learn quickly, for the reason that in the rapidity of acquisition few associative connections are formed. Examples of this are found in cramming, where practically everything is forgotten after examinations, or, in the case of the lawyer who quickly learns all the facts bearing on a particular case but promptly forgets them after the trial. Things in which we lose interest are quickly forgotten, for the reason that we do not think of them and revive them. Likewise, acquisitions of memory which are not used and kept fresh gradually fade out of consciousness. Failure to use a foreign language results finally in its loss. However, a very instructive fact comes to light in such cases. It has been found that the time taken to relearn forgotten material is much less than that originally required, showing that the material was not entirely lost—that the effects of the former experience were really retained. This has led some authorities to declare that nothing is ever completely lost—that whatever we learn persists, and is a factor in determining our conscious states even though it may not be recalled. There is much truth in this view, although it is difficult to determine exactly how much the residue of our past experiences influences the character of consciousness. In some cases we know that the influence is considerable. It is safe to say that even though the form of our impressions is forgotten their essential substance remains beneath the surface of memory. Every experience plays its part in the fashioning of our mental characteristics and leaves its mark, although its outline may be effaced by the lapse of time. We often hear persons of intelligence express the opinion that they have wasted their time absolutely on this or that study in college because they have forgotten it. The more we examine the nature of mental life the more we are convinced of the error of such a view.

Such are some of the conditions of normal forgetfulness. Special cases of forgetting, sometimes amounting to complete loss of memory, accompany certain changes and abnormal conditions of the organism. Old age, fatigue, bodily disease, accidents, exhibit peculiar forms of forgetting. With the advancing general dissolution of the nervous material in old age, experiences fail more and more to be retained. This accounts for the fact that old people easily forget recent experiences, and live more and more in the memories of their youth. They lose their memories in the reverse order of acquisition. Their first experiences are the last to be forgotten. This is in accordance with the *law of regression: The dissolution of the nervous system takes place in the reverse order of its development.* The earliest functions are the most stable and the last to be affected. On the other hand, the latest functions are less stable and the first to be affected in general decay. The loss of memory as one gets older differs for different kinds of materials. The words for concrete ideas are more easily forgotten than those for abstract ideas. Thus, proper nouns are forgotten before adjectives and verbs. The reason for this lies in the fact that the connections between the name of a particular object and the object itself are less frequently made than in the case of abstract ideas. The particular object may be thought of or imaged without the word, while the thought of an abstract idea involves the image of the word in nearly every instance. Therefore, it is more firmly fixed and has more associative connections for memory to work upon. Consequently, the weakening of associative connections in old age affects the names for particular things before it does those for general ideas.

In extreme fatigue there is a marked falling off in ability to recall, especially the ability to recall language symbols. When fatigued, words come to us hesitatingly, and at times the right word cannot be revived at all. In cases of severe illness accompanied by high fever there is often a complete lapse of memory. A similar loss of memory may be noted during periods of extreme excitement or emotional disturbance. An interesting lapse of memory takes place after an accident in which we lose consciousness. On recovery we find that we are unable to recall the events which led up to the accident. We may forget the events of minutes, hours, or even days preceding the accident. A blow upon the head may in extreme cases cause us to forget all our past experiences. Sometimes it may cause a partial loss of memory only—memory for a certain class of facts, a foreign language which we have acquired, or specific forms of sensory content —visual or auditory images of certain kinds.

**Defects of Memory.**—Defects of memory have been classified into three groups: (1) Amnesia, or loss of memory, (2) Hypermnesia, or exaltation of memory, and (3) Paramnesia, or falsification of memory.[1]

*Amnesia* is the inability to form or retain mental impressions. *General amnesia* is best represented in idiots, in cases of dementia, or extreme old age, when a weakened mentality makes the acquisition and retention of any form of memory material impossible. *Partial amnesia* is the inability to recall certain groups of experiences, as, for instance, when the patient cannot remember letters, the names of his friends, or the knowledge of Latin, or other languages, while memory for other things is normal. Such loss of memory may follow illness or injury to the brain.

[1] For a more extended classification, see article, "Memory (Defects of)," by Professor J. Jastrow, in Baldwin's "Dictionary of Philosophy and Psychology."

*Hypermnesia* is an exalted power of memory. It usually exhibits itself as an unusual ability to remember certain groups of facts or impressions. This abnormality of memory is the basis of the marvellous feats of mental reproduction that are sometimes reported. Blind Tom, who could remember a long selection of difficult music after hearing it once, and Seneca, who claims that he was able to repeat two thousand names in the order that they were read to him, illustrate this exalted form of memory.

*Paramnesia* is a defect of recognition, sometimes called *illusions of memory*. In some cases a purely imaginative scene or event may be accompanied by a false recognition, making it appear to the subject as a real occurrence. Many of the delusions of insanity are of this nature. In more normal individuals a pure fabrication may, after being repeated many times, acquire a false recognition, so that such individuals come in time to believe their own stories. It may also cause that strange "feeling that all this has happened before" which every one has at times experienced. In such cases the recognition of some similar former experience momentarily but falsely attaches itself to the present event. The opposite process may sometimes take place, when a familiar scene may temporarily appear to us as new and strange. Here the associative connections are severed for the time, and the feeling of familiarity drops away and is replaced by the feeling of strangeness or unfamiliarity. This may be produced experimentally: Pick out a familiar word like "*and*" on a page of print. Stare at it for several minutes, and presently it will appear as a foreign and unfamiliar thing. The explanation lies in the fact that the meaning of the word, its associative connections, drops away from the perception, taking with it the feeling of familiarity. Illusions of memory may also be brought about by suggestions. In the process of "sweating" a witness by detectives and police officers the normal associative connections are weakened by the extreme mental fatigue and excitement caused by the inquisition. Under such conditions a highly nervous or mentally unstable witness becomes a prey to suggestion, and may be made really to feel that he saw or took part in events entirely foreign to him. He may in this way be induced to give false testimony. Children are especially subject to falsification of memory by suggestion. It is, therefore, extremely unsafe to depend upon the testimony of children, elicited by questions containing even the slightest suggestions in them.

**Function of Memory.**—In our study of memory we should not lose sight of the fact that its real function is not the mere impartial reproduction of the past, but the revival and identification of only those past experiences which are appropriate to the needs of the present situation—the selection of those pertinent parts of the past which can be incorporated into our present thinking and acting. While this selection is largely controlled by the nature of past associations, the revival of these associations in all cases, save probably in mere fancy or day-dreaming, takes place within larger movements of consciousness dominated by purposes, plans, desires, feeling, and volitional impulses. The memory process, then, does not stand by itself, but is involved in larger complexes of consciousness in whose interests it functions. It, however, plays no insignificant part in our larger conscious life. It frees us from the narrow limits of the present moment, and enlarges the mental horizon by re-presenting conscious experiences of the past to which it gives the stamp of reality and genuineness.

# CHAPTER XI

## IMAGINATION

**Memory and Imagination.**—We have seen that the ability to form mental images of past impressions is the basis of memory. Since imagination in its larger sense means the process of forming reproductive as well as productive images, it follows that memory and imagination overlap. Reproductive imagination is really a part of memory. Memory in its exact sense is the definite recognition and identification of these reproductive images. But in many cases the purpose of thinking does not require that reproductive consciousness should advance to the stage of recognition. In such cases the sensory contents of former experiences are merely revived but not recognized. The reproduction of a past experience does not always involve the recognition of it. For example, in contemplating my summer outing, fleeting images of places and routes of travel may arise in my mind without any consciousness of the fact that I have experienced them before. In geometry I may image a right-angled triangle without recognizing it as any definite former experience. In perception, I am constantly supplementing actual sensations given by the stimulus by images based upon past experiences, but I do not recognize or identify them as such, and so I cannot be said to remember them.

The amount or degree of recognition accompanying reproductive images may vary from clear and vivid to vague and hazy recognition. Reproductive imagination and memory, therefore, shade off gradually into each other, so that it is sometimes difficult to say whether a given image is a memory image or an image of reproductive imagination. As we have already said, for the popular mind reproductive imagination passes for memory. This finds a partial justification in the overlapping of memory and reproductive imagination, and in the gradual shading of the one into the other. But in the more critical analysis of psychology we are forced to make a distinction between them.

**Kinds of Imagination.**—The most striking thing about imagination is the formation of images of things which have never been given in actual experience—"creations of the imagination," as the popular phrase goes. Our power to think events that never happened to us, to mentally picture things that we never saw, or even to image things that never existed is what is commonly meant by imagination.

There are, then, two kinds of imagination: (1) *Reproductive imagination*—the imagination which reproduces former experiences, and (2) *productive imagination*, which constructs mentally things which we have never experienced before. Productive imagination may function in the interest of some plan or purpose, or it may act spontaneously, *i. e.*, unrestrained by any purpose or voluntary effort on our part. The former we shall call *constructive imagination*, and the latter *fancy*. *Constructive imagination* may be further divided according to the general field in which it operates. The following is an outline of the different kinds of imagination so far mentioned.

- I. Reproductive Imagination.
- II. Productive Imagination.
  - 1. Constructive.
    - (*a*) Scientific.
    - (*b*) Mathematical.
    - (*c*) Literary.
    - (*d*) Artistic.
  - 2. Fancy.

**I. Reproductive Imagination.**—Hobbes called attention to two kinds of imagination, the one, "as when one imagineth a man or horse which he hath seen before" and the other "as when from the sight of a man at one time and a horse at another, we conceive in our mind a centaur." Such is the difference between *reproductive* and *productive* imagination. The former merely reproduces our past sensations and perceptions. Images are, however, never exact duplicates of former experiences, for otherwise we should confuse them. We always know the difference between the image and the actual sensory experience, except in the case of hallucinations. The psychological differences between the image and the perception we have already pointed out in the first section of the chapter on memory. In some abnormal conditions, these differences become obliterated, and the image may then take on the reality of perception. It is reported of an English portrait-painter that his reproductive visual images were so vivid that he required only one sitting of his subject. After that he was able to image the position, features, clothes, etc., of the subject so clearly that he could finish the portrait without the presence of the subject.

**II. Productive Imagination.** — Reproductive imagination is limited in its range and variety by the range and variety of perceptual experiences. On the other hand, *productive* imagination is free. This last statement needs modification. For even productive imagination depends upon past experiences. Imagination cannot create a new world. We cannot imagine things entirely new, for the material of imagination must come from the past. The most fantastic creature of the imagination is formed out of the sensory elements of our actual perceptions. Try as hard as we may, our wildest fancies cannot transcend the elementary forms of real experiences. Sensation is therefore the basis of all forms of imagination. A highly productive imagination calls for a broad basis of perception to draw upon. The productivity of imagination consists, therefore, in recombining the elements of old and familiar experiences into new forms.

Reproductive images may be incorporated into productive imagination, as, for example, when we combine the head of a man and the body of a horse to form a centaur. Further, an image of productive imagination may vary only slightly from some former experience, or it may differ in a marked degree from it. There is no absolute distinction between reproductive and productive imagination. The difference is a relative one, resting in the degree to which any given image corresponds to original experiences.

The products of productive imagination may vary from the most fantastic dream to the great creations of art, literature, science, invention, etc. And here we make a distinction between the imagination that works according to some plan or purpose and is controlled and guided by voluntary effort, and the imagination that is uncontrolled—without purpose or plan, capricious, and eccentric. There is a difference between the imagination that produces a poem or drama, a painting or symphony, and the imagination that builds air-castles. The first we call (1) *constructive imagination;* the second is mere (2) *fancy.* These two kinds of imagination are sometimes called *active* and *passive imagination.* Constructive imagination is *active* in the sense that voluntary control is present, holding the mental construction to a definite plan. Fancy is *passive* in the sense that images arise spontaneously—without any apparent active control from within. In this case, whatever happens to arise in consciousness is passively received without effort on our part to restrict or restrain it.

*Constructive*, or *active imagination* manifests itself in (*a*) *scientific* and (*b*) *mathematical* theories, and in (*c*) *literary* and (*d*) *artistic* productions, and in other ways. The builder, the inventor, the author, and the artist, as well as the man of science, all rely upon constructive imagination. Although it is commonly said that the artist, the builder, the author, etc., are free from all objective control—are free to create subjectively their worlds of ideal existences—this freedom is only relative. No creation of art can wholly disregard the world as it really is. The true artist must constantly keep the laws of nature in mind. Likewise, while the author may invent new scenes and create ideal men and women to enact them, nevertheless he is controlled in the formation of his imaginary world by the laws of human nature. He incorporates the real characteristics of actual scenes and real people in his creations.

Sometimes the creations of genius come to the artist or author in a flash—"inspired," as we say. It is the common belief that in such "inspired moments" genius transcends the ordinary world of experience and catches glimpses of a higher reality. However this may appeal to the popular mind, it will not stand the test of sober analysis. No creation of genius can be found that does not have a broad background of real experience behind it. The great "poem does not sing itself," but springs up out of a ripe and extended experience, even though it may suddenly appear as a happy thought or inspiration. It is not a transcendental importation, but an idealized and transformed mundane experience awaiting just the right combination of circumstances to call it forth.

On the other hand, many great productions of art and literature are plainly the result of prolonged and intense conscious effort. They are forged by an indomitable will out of the raw materials of experience. With respect to the source from which these two phases of constructive imagination draw their material there is no difference between them. They differ only in the manner in which they function, one easily, without effort or evident plan, and the other with intense effort and purpose. But both draw their material from the same source—experience.

In *fancy*, the restraint of purpose or plan and the controlling influence of real events are in abeyance. Imagination here has a free rein, creating for us a fantastic world of giants and pygmies, fairies and demons, harpies and griffins, or giving us an imaginary existence in day-dreaming and reverie, where we can build our air-castles to our heart's content and give expression to all manner of unrealities. Here are exhibited the freest images of the mind. Yet even these creations of imagination show their dependence upon real experiences. The fairy or the griffin must needs be formed in the moulds of past experiences. The relation of fancy to constructive imagination is really one of degree, depending upon the amount of control involved in the imaginary output. The line between them is not sharply marked at times, as is illustrated by such creations as "Alice in Wonderland" or "Gulliver's Travels." In both cases the products of fancy are subordinated to a definite constructive plan.

The rise in consciousness of these free and uncontrolled images is facilitated, and their vividness increased, by the use of certain drugs. In hashish intoxication, the flight of grotesque images becomes very marked.[1] Opium and alcohol also loosen the normal control of images and start unusual "flights of fancy," sometimes even causing hallucinations.

The image of productive imagination is a new experience —respresenting something that has not happened to us before. Productive images have the feeling of newness. Therefore the content attracts and holds the attention more vividly than do the contents of reproductive images. The productive image is filled out more completely, and is more often an end in itself, *i. e.*, thought of for its own sake; while the reproductive images, especially images of memory, are used to symbolize former experiences and are not in themselves an end of consciousness. As we become more and more familiar with objects or events, mental images which at first merely copy or reproduce them tend more and more to symbolize the objects or events, and in so doing lose much of their sensory content. Reproductive images, in this way, come to be the vehicles of meaning, *i. e.*, stand for something besides themselves. After a number of objects or events of the same kind are experienced, we do not, when we wish to think of them, revive each and every one in terms of their

[1] See James: "Principles of Psychology," vol. II, p. 121.

sensory contents. We shorten the process of thinking by allowing a single image to stand for all the individual images. In this way reproductive images begin to carry meaning and so to take part in a larger process—the process of conception—in which we think our past experiences not as single individual experiences, as we do in reproductive imagination, but in classes, or groups of experience. For instance, instead of calling up one by one the image of every horse that we have seen, we are able by means of the concept to consolidate all these single past experiences into one thought. A single image can then stand for all horses. But a single image cannot reproduce the sensory content of all past experiences with horses, nor as a symbol of them does it need to do so. For in the larger movements of thought attention is withdrawn from the image as sensory content and placed upon its meaning. The image, in this case, instead of reproducing a single past experience in all its sensory details, symbolizes all past experiences of the same kind. The reproductive image, therefore, undergoes a transformation in its function. At first it reproduces the sensory content of a given experience. Later the image may be used to symbolize all experiences that belong to the same class, and in so doing it drops into the background of consciousness, because attention shifts from the image to its meanings.

The productive image, on the other hand, just because it is in itself a new experience and cannot be used to symbolize familiar past experience, is oftentimes less vague and sketchy and more stable in sensory content than the reproductive image.

**Types of Imagination.**—We have seen that the content of imagination is the same kind of mental stuff as that of sensation. Imagination may be carried on in terms of any one or all of the senses. Our images, therefore, may be visual, auditory, kinæsthetic, tactual, gustatory, or olfactory. In recalling a past or imagining a new scene, we may mentally picture the forms and colors, mentally hear the sounds, or feel the actions, etc., which were present in the original experience. Some individuals have fallen into the habit of using one kind of sense material more predominantly than any other in their mental imagery. This gives rise to types of imagination, according to the sensory content which is used in thinking. Some persons recall in terms of vision, others in auditory terms, and others in motor images, etc.

**Visual Type.**—The visual type is most common. Past experiences and creations of imagination come to us in visual sensory material. We see the past and construct the future in the "mind's eye" so to speak. Sculptors, painters, and architects are largely visualizers, although to be a good artist does not mean that one must image in terms of vision. Kinæsthetic or motor images may be substituted for the visual. Galton found in his investigation of imagery[1] a number of artists of note who were not of the visual type. Professor James says of himself: "I am myself a good draftsman and have a lively interest in pictures, statues, architecture, and decoration, and a keen sensibility to artistic efforts. But I am an extremely poor visualizer, and find myself often unable to reproduce in my mind's eye pictures which I have carefully examined."[2]

**Auditory Type.**—As a rule, musicians are of the auditory type of imagination. Beethoven composed his symphonies after losing his hearing. A good illustration of the auditory type is furnished by the playwriter, Legouvé, who said to his friend Scribe: "When I write a scene, I hear and you see. At each phrase which I write, the voice of the person speaking strikes my ear. The diverse intonations of the actors sound under my pen as the words appear on my paper." It very often occurs that the auditory type is combined with the language motor type. Persons who image the sound of the words also image the movements of their enunciation.

[1] "Inquiries into Human Faculty," p. 84.
[2] "Principles of Psychology," vol. II, p. 53.

**Motor Type.**—Occasionally an individual may be found whose imagination consists largely in images of movement. They habitually recall past experiences, or imagine future events, in terms of the movements contained in them. In recalling words, they image the movements of articulation. They think of objects in terms of the eye-movements required in perceiving them. The student may observe the tendency to image the movements of articulation by thinking such words as "bubble," "toddle," "pepper," and observing the resultant motor images.

These three types, *visual*, *auditory*, and *motor*, are the only well-defined types. Tactual, gustatory, and olfactory images are possible, but they hardly ever usurp the chief place in the imagination of normal individuals. The case of Zola, the writer, is interesting because of its rarity. He could recall and image odors more distinctly and more easily than colors. Nearly every object had, when he recalled it, a distinctive odor. When he thought of certain streets, cities, or even the seasons of the year, definite images of smell arose in connection with the thought of them.

The explanation of these types of imagination will probably be found in the fact that some individuals form the habit of thinking in terms of some one sense to the exclusion of the others. A predominating interest of some kind may determine and fix the habit. How far heredity may be involved as a factor we do not yet know.

A curious error has sometimes been made in applying the psychology of the types of imagination to education. It has been suggested that the "eye-minded" child should be taught largely through the eyes, and the "ear-minded" through the ears. Aside from the general principle that the young should receive training in just those abilities in which they are lacking (and so if a child shows inability in visual imagery, he should for that reason be given opportunity to develop it by supplying him with sensory visual material)—aside from this consideration, there is the further psychological fact that a child who is lacking in visual imagery may possess an excellent visual perception, so that he is able to make accurate discriminations in everything that he actually sees. He may, therefore, be able to get more through the eye than through the ear in actual presentation. But what he gets through the eye he may translate into auditory terms, retaining, and recalling his acquisitions in these terms. The conditions which make accurate perception in the presentation of a given sense possible may not accompany accurate imagery in that sense. Imagery of the material presented may take place easily in terms of another sense.

**Mixed Types.**—In most individuals, the contents of images are drawn from all the senses—sometimes from one and sometimes from another. One may have visual imagination for one kind of experience, and auditory or motor for another. Visual, auditory, and kinæsthetic sensations furnish most of the content of imagination. Gustatory, olfactory, and tactile sensations are represented less often. Probably no person has one type of imagination alone.

**Methods of Determining the Types of Imagination.**—Francis Galton's statistical study of the imagination was the first important attempt to determine the nature of imagination in individuals.[1] He prepared a list of questions about mental images, which he required a large number of persons to answer. In each case he relied upon the direct self-observation of his subjects. By recalling certain scenes or objects, we can usually determine by careful observation, the types of our mental images. However, more objective methods have been used since Galton's time.

One simple way of determining whether a subject is visual or auditory in his imagery is to require him to write as rapidly as possible a list of objects that are characterized by well-marked colors. Let him continue to write for five minutes. Then stop him and after he has rested for some minutes require him to write a list of words characterized by sounds,

[1] "Inquiries into Human Faculty."

allowing him the same length of time. The visual type will write more names of objects characterized by color, while the auditory type will write more names of objects characterized by sounds.

The learning method has also been used for this purpose. For instance, make several lists of letters, twelve in each. Have the subject read one of the lists, not allowing him to pronounce the letters to himself. See that the only impression he receives is the visual one. Find out how many letters he has learned of this list after reading it once. Then read another list of equal difficulty to the subject and determine how many of this list he can remember. Repeat each experiment ten times, taking careful note of the number and character of the errors. If the subject learns a much larger number of the lists he reads himself than of those that are read to him, he is visual in type. If, on the other hand, he learns more of the lists read to him, he is auditory in type. The nature of the errors is also an indication of the type of imagery employed. The visual type will confuse the letters of like appearance, c and e, p and q, u and v. The auditory type confuse letters of like sound, b and d and p.

The literary productions of writers may be analyzed and the types of images employed determined. Thus Miss Calkins[1] quotes a poem from the blind poet, Philip Marston, and shows that he uses only one color image in the whole poem, while images of sound and odor are plentiful.

**Imagery in Synæsthesia.**—Cases of synæsthesia furnish interesting instances of various kinds of imagery. Synæsthesia is the term which we give to those forms of associations which some individuals experience, in which the presentation of an object is accompanied by mental images in another sense. For instance, some persons image different colors when they hear or think of tones. The different tones have for them certain definite colors. The high tones have bright colors and the low tones the darker colors. The days

[1] "Introduction to Psychology," p. 191.

of the week, the months, the seasons of the year, also arouse, in some cases, images of color. Even the letters of the alphabet, names of objects, or proper names, may be associated with images of color. Galton[1] reports a case in which the vowels were imaged in colors while the consonants were always purplish-black. This subject says: "For example, in the word Tuesday, when I think of each letter separately, the consonants are purplish-black, u is a light dove-color, e is a pale emerald green, and a is yellow; but when I think of the whole word together, the first part is light gray-green and the latter part is yellow." This form of synæsthesia, the arousal of concomitant color images, has been termed *chromæsthesia.*

Another instance of synæsthesia is the "*number-form.*" Some individuals always image the digits and lower numbers (usually not beyond one hundred) as occupying a definite position in space and arranged in a certain form. The hours of the day, the days of the week, and the months of the year may also have a definite imaginary arrangement which is always constant for the same individual, but for different individuals the forms are never the same. These number-forms will sometimes be found in several members of the same family. Baldwin has published number-forms of five different members of the same family[2] and reports another case of three in a family who have them. He is of the opinion that they are hereditary in origin. Other authorities think that they are due to fixed associations formed between numbers and spatial positions.

**Concrete and Symbolic Imagination.**—So far we have considered images only as imitating or reproducing the sensory content of former experiences. This is *concrete imagination.* If I imagine the appearance of an object, I have a concrete visual image; if I recall the sound of a bell, the image is concrete; if I imagine the feeling of velvet, the image

[1] "Inquiries into Human Faculty," p. 149.
[2] Baldwin's "Dictionary of Philosophy and Psychology," pp. 654–5.

is also concrete. So all imagination which brings back the sensory qualities of experiences is concrete.

If, on the other hand, I recall the word or other sign which stands for an experience without reviving the sensory experience itself, my imagination is symbolic. For instance, if I remember that a certain gown was red, I may merely recall the word and not the visual appearance. There is a constant tendency, as we become more and more proficient in the use of language, for the concrete sensory material of our images to be replaced by word images (verbal imagery). These word images are either auditory images of the words as heard or motor images of throat movements in articulation, or visual images of the words as printed or written. The blind may have tactual word images as well as auditory.

Some persons mentally picture the form of the word which represents their experiences; others hear words as though they were spoken by themselves or by some one else; while others image the feeling of the word in the throat and lips. Victor Egger reports "that he hears his thoughts as it were in auditory word images." Tennyson, whose verse is noted for its rhythmic harmony, must have had this form of verbal imagery very highly developed. Still others image the words expressing their thoughts in terms of movements in throat and lips. Doctor Stricker, in his monograph on speech images says that he feels his thoughts in mentally half-suppressed whispers, not heard but articulated mentally. In this verbal-motor type of imagery, there is a strong tendency for the images of articulatory movements to bring about the movements themselves, so that those who possess this form of imagery are apt to whisper or talk to themselves.

Most of us have noticed that as we grow older we lose the ability to recall the sensory contents of our experiences. The "look" and "sound" of things will not come back to us as vividly and accurately as they did when we were children. We have attributed this to a loss of imagination. It is due not to a loss of imagination, but to a change in the form of imagination. The original and primary concrete image has been displaced by the word or the symbolic image. Our whole education is largely a training in translating our experiences into language symbols. We could make little progress, if we were obliged to think our experiences in their original concreteness; so we use language to symbolize them. As we increase our facility in thinking, we find that we cannot stop to image all of the concrete "stuff" of experience. This would be a hindrance to abstract thought. We know that the American flag is made of stripes of red and white, and has a field of blue, etc., but we do not now have to picture these forms and colors. We let the words stand for them without imaging the concrete realities. Galton found that many men of science were practically without concrete imagery, and concludes "that an overready perception of sharp mental pictures is antagonistic to the acquirement of habits of highly generalized and abstract thought."

When images first began to play a part in the mental life of the child, they were necessarily copies of the concrete qualities of objects. They were vivid and detailed reproductions of sensations and perceptions. But later when he became familiar with the word symbols which stand for the qualities of the sensation, he gradually substituted the word symbol for the experience itself when he wished to think of it. In some cases verbal imagery is all that is retained of our past experiences. Thus I may remember that a certain man is tall and has red hair, but I may not be able to form any concrete image of him whatsoever. Indeed, as our education proceeds, we come more and more to rely on words rather than on the imagery of concrete objects in recalling the past or planning the future.

The onomatopoetic tendency of certain words is an interesting fact in the substitution of language symbols for the concrete experiences. Such words as "hiss," "rumble," "crack," "swish," "buzz" attempt to imitate and preserve the auditory sensory qualities for which they stand. The child calls the dog "bow-wow" for the same reason. The imitation in the symbol of some sensory quality of the thing symbolized is a survival of concrete imagination.

**Image and Idea.**—The term "idea" has a number of meanings which are in current popular use. Even in the literature of psychology there is no uniform usage. In the old traditional doctrine of the association of ideas, an idea is some definite permanent meaning looked upon as a psychic existence with powers of attraction and repulsion, analogous to the physical atom. Some ideas attract each other and flock together in the mind, while others repel each other. A more modern usage makes idea practically synonymous with concept. Idea, accordingly, is an image of an object plus the object's meaning. The idea of a horse is the horse-image together with the horse-meaning. In this case, while the idea includes both the image and the meaning, it emphasizes the meaning rather than the sensory content of the image. In an idea we attend to the meaning and not to the image.

A more satisfactory use of the term and one agreed upon by a number of psychologists is that which makes idea "the reproduction, with a more or less adequate image, of an object not actually present to the senses."[1] An idea is, therefore, the reproduction of a perception. I have an idea of my dog when I recall his appearance through reproductive images. Ideational processes, then, are processes of mental reproduction in which there is a succession of ideas.

**Training of Imagination.**—Since imagination, both reproductive and productive, draws its content from original sensory experiences, it follows that the beginning of imagination lies in accurate sensory acquaintance with things as they really are. The accuracy and vividness of reproductive images depend upon the accuracy and the vividness of the percept. Beyond this it may be cultivated in any particular

[1] Definition of idea given in Baldwin's "Dictionary of Philosophy and Psychology."

line to almost any extent by continual practice. The wonderful visual imagery of Pillsbury, the chess-player, who was able, blindfolded, to play twenty games of chess, requiring him to image and keep in mind all the combinations of the chessmen in these twenty games, is due to practice in doing just that thing. It should be noted, however, that his ability to image other than chess-board situations was not above the average. In the first place, he made himself perfectly familiar with the chess-board. Then practice in imagining the different positions of the men on the board made it unnecessary for him to have the actual board before him. While such overtraining of the imagination may be valuable for certain specialized purposes, it is doubtful as a general educational procedure. The imagination can and should be cultivated, but not on any special kind of material to the exclusion of all others.

**Imagination as a Means of Supplementing the Present.**—It is unnecessary to dwell upon the fact that imagination enriches the presentations of the present moment. What is actually given in sensory content is poor, indeed, when compared with the wealth of material poured in by the imagination. The present is supplemented not only by the past through reproductive imagination, but it is modified by the future through creative imagination. The actual and the real become enlarged by the ideal. For a creature without imagination there is nothing but the sensory bareness of the actual present moment. For him there would be no revivals of the actual past, no constructive images of science, literature, and art, no fairy-tales, and no myths.

**Imagination and Behavior.**—In the first stages of voluntarily formed motor habits, the image of movement precedes the movement itself. For instance, before picking up my pen, I may image the finger and arm movements necessary to perform the act. Or before pronouncing a word, I may form the images of the movements required in articulation. When habits of action are once formed, images of almost any kind may instigate an action. The image of the pen in my hand, or the image of the sound of the word may precede the proper movements of execution. So the image is a means of controlling our behavior. The man who successfully carries through a great activity, whether it is a military campaign or a business venture, is the man who can image his actions and their results—in other words, the man who can imagine the future as different from the present. The man of action, the captain of industry, is quite as much the man of imagination as the artist or the author.

There is a general belief that it does not matter what kind of images one allows to take form in his thoughts so long as he does not commit the overt act. Psychology cannot concur in this belief. We have already seen that the kinæsthetic images—the images of movement—possess a strong tendency to bring about the actual movement itself. No one can allow the image of an act of any kind to rest in his thoughts without paving the way to the actual act. Sooner or later forms of behavior which one continues to image will become a reality.

Because of this tendency of images to pass over into overt acts, we may say, with certain modifications, that we actually create our futures through the kind of images we entertain.

# CHAPTER XII

## ASSOCIATION

Although we have already referred to the associative connections which bind experiences together, we must here consider more systematically this tendency of conscious states to be associated into complexes and groups which hang together with varying degrees of cohesion. It is a matter of common observation that mental states are held together into units, groups, and constellations, so that if one member appears in consciousness, the other members follow.[1] It is evident that some mental states are intimately bound together, while others are connected more loosely. The thought "2 times 2" is always followed by the thought "4"; the word "honesty" is less closely connected with "is the best policy," while the connection between the thought of a circle and the thought of immortality is still less intimate; nevertheless there is a connection.

These connections are acquired in the course of experience and serve to hold the component parts of our mental life together. Without these connections, there could be no such thing as thinking, unless a mere jumble of mental states could be so named. If a given mental content were just as liable to call up one thought as another, there would be no coherence of thought. Indeed, the formation of associative connections is the backbone of the organization of consciousness. Education is really the process of forming associative

[1] The language here is, of course, figurative. When one member of a group of experiences is in consciousness, we do not, like some of the old associationalists, suppose that the other mental states of the group are actually in existence outside of our consciousness, awaiting their turn to come in. We mean by association only the possibility of one mental state being revived when another is actually in consciousness.

connections. Our formal educational program puts together the things that we think should go together in the child's mind, and presents them to the child in organized systems of knowledge. We know that the mental connections thus formed will dominate his later thinking and acting. With the visual appearance of the letters "c-a-t," we associate the sound "cat"; with "nine times nine" we connect "81"; with the idea of "first President" we put the idea of "Washington," etc. As the child progresses along the educational route, we attempt to fix in his mind what we consider are the proper mental connections in science, literature, art, and all the other disciplines of knowledge. At the same time the child, in his daily contact with life in the home, on the street, with his companions, is forming his own mental connections. So gradually his mental content settles down into connected systems. What he thinks and what he does in any given situation depends upon the nature of the mental connections he has formed in the past. Even what we commonly call character is a matter of mental connections. The difference between the pessimist and the optimist, the rogue and the honest man, the silly dandy and the man of brains, lies in the nature of their mental connections. In every phase of mental life, from the association of simple sensations to form a perception, to the union of ideas and desires to form our ideals, associative connections are determining factors.

**Formation of Associations.**—Associations are acquired mental connections. In attention, certain parts, phases, aspects, or features of a total object or situation fall successively or simultaneously within the focus of consciousness. When later any part, aspect, or feature of the object or situation is presented or is thought of, the other aspects also appear in consciousness. This is the fundamental fact of association. On hearing the noise of a street-car, which I cannot see, the visual image of the car arises in my consciousness because the auditory and visual sensations have been associated together in the actual experience of the car.

**Motor Connections.**—There is a large group of associations that have not always been included in discussions of association for the reason that one of the terms of the association is not a mental state. I refer to the connections between states of consciousness and motor reactions. Here we have the whole field of motor habit formation before us. Certain acts become connected with certain mental states, so that the acts are always called out by the mental states. The sight of my pen on the floor prompts me to pick it up. The soldier hears the command "Halt!" and stops short. The telegraph operator sees a word and his hand immediately executes a number of dots and dashes. All these are the result of acquired connections which have been formed in previous associations.[1] What happens in such cases is that the sensory brain centres discharge directly into the motor centres and pathways.

**Mental Connections.**—The purely mental connections make up a large and varied group of associations. The closest associations are those between the different sensations which enter into a perception. Thus the color, form, odor, and tactual qualities of the rose form a compact and unitary group of experiences. If the velvety softness of the petals is experienced on the finger-tips, the other sensory qualities of the rose spring into consciousness as images, and we get an idea of the rose as a whole. This process of recall we have named *complication.*

In the association of different perceptions, the terms of the association are not so closely combined as is the case in the union of sensations in the perception. The percepts stand apart in the combination and preserve their identity. They are, however, bound together by certain relations.

[1] Connections may also be acquired between one motor reaction and another. This is manifested in the so-called "chained reactions." A habit composed of several individual reactions following each other may, if started, run itself off, without conscious direction. The first reaction arouses the second, the second the third, and so on until the end. Thus if the first bar of a familiar piece of music is consciously executed, the rest will play itself, as it were.

These relations may be established either by the fact of simultaneous and successive presentations, or by the fact of similarity, contrast, cause and effect existing between presented objects. Objects or events that are presented at the same time acquire an associative connection. Likewise, if one object or event follows another, the two become tied together in a more or less effective mental union. The different parts and persons in the scene which I witness as I pass through a workshop are associated together merely because they are experienced together. Likewise, the different events and scenes of my summer's excursion are bound together because they follow each other. It was formerly thought that immediate succession was necessary for the formation of associations, but it has been found that associative ties are formed between more or less remote members of a series of events or objects. Each member of the series becomes linked (in a lessened degree, to be sure, but nevertheless in a degree capable of demonstration experimentally) to the member which comes next but one, and also to the one which comes next but two, etc. The associative connections decrease in strength as the members become more and more remote. This indicates that associative links form not only between the members serially, but that there is a tendency for successive presentations to form into a group in which any one member is linked to all the other members as well as to the one preceding or following it.

It has been found experimentally that the arrangement of individual experiences into groups or higher units of experience serves to intensify the associative connections and weld the parts more firmly together. The tendency of experiences to form into higher units is called the *principle of integration*. For instance, the events of a summer spent in Europe are connected serially one to the other. But the events tend to form into units of experiences, which are integrated into groups instead of a mere series. The German scenes and events form what we have called a higher unit. The French, Italian, and English experiences form others. What happened in Germany therefore gets a special German connection, and so with the other parts of the journey.

We may sum up all the cases of association so far mentioned under the principle of *contiguity*. Things that are experienced together or thought together form associative connections.

There is a difference between associations that are formed passively through mere external contiguity and those that are actively formed because we attend to the logical relationships which exist between the parts of our experience. The latter are much more permanent. Mere contiguity, however, rarely ever works alone in the formation of associations. There is almost always some thread of interest or some relationship which ties experiences together. The most important of these relationships are similarity, contrast, cause and effect. Things that are similar or contrast sharply, or are related as cause and effect, attract and hold the attention when they are presented. They are, of course, experienced at the same time, also, but attention actively connects them because they are similar or because they contrast or stand in the relation of cause and effect. There are many other relationships that bind original experiences together. Even time and space relations of things may be actively noted, and for that reason aid in forming associations.

There are other important conditions under which the principles of contiguity, similarity, etc., operate in the formation of associative connections. For instance, the presence of a *purpose* or *plan* in the mind will select and intensify certain parts of our experience, and so control the formation of associations. Thus, the desire or purpose to remember the names of the voters in his district will facilitate the formation of name associations in the politician's mind.

Closely related to purpose in controlling the formation of associations is the dominant interest in the mind at the time.

Mental states are related because of interests. If one is interested in athletics, athletic scores and records form into a closer system of associative connections than they would if the interest were not present.

Experiences that are vivid and clear are connected more closely than those that are unclear. This is really a repetition of the statement already made that the things we attend to are associated together. The repetition of experiences intensifies and fixes the associative bands between them.

Everything else being equal, the most recently formed associations show the strongest associative ties. As associative groups become older, the links between the members rust away, so to speak. The experiences of yesterday are more firmly associated than those of a year ago.

An interesting fact has been demonstrated experimentally concerning the age of associative connections. Of two different associative connections of the same strength at any given time, the older is more permanent (will be retained longer) than the younger. If, for instance, I am now equally conversant with two groups of facts of the same difficulty, the group learned last will fade from memory first. This holds only when the time between the learning of the two groups is long enough to enable the associative connections of the first group to settle. For it requires a certain amount of time for associations to fix themselves.[1] On the other hand, if the learning of the one set of associations is immediately followed by the learning of another set, the latter sometimes weakens the former. This is known as *retroactive inhibition.* When, after giving my attention to one group of facts, I turn immediately to another group, the associations formed in the latter tend to inhibit those in the former. Retroactive inhibition is most active when the material of the two groups is of the same nature. Its effect disappears after a time. A familiar illustration is furnished in every-day life. It often happens that when we are trying to recall the name of a cer-

[1] This is known as Jost's Law.

tain person or place which we are usually able to do, some one will suggest an incorrect but similar name. This suggestion blocks the proper association and we find ourselves unable to recall the familiar name.

The maturing or ripening of associative connections is also illustrated in common experience. If, after struggling for some time with apparently little success to learn a certain system of facts, we lay aside the task until the next day, we are often surprised to find when we return to it that we have really mastered it. The associations have become fixed over night.

All through this section we have spoken as though one mental state could form an associative connection with another mental state. Of course, the student understands that this is only a figurative way of stating the matter. One mental state cannot form a direct connection with another mental state. The connections are always made through the brain. One of the fundamental presuppositions of this book is that every mental state has a physiological brain process back of it. We believe that when two mental states are connected or associated the real connection is made in the formation of nervous pathways between the centres involved. The physiological basis for association we shall take up after discussing the second part of association—that of associative recall.

**Associative Recall.**—Since the time of Aristotle, there has been a great deal of discussion concerning the principle of association. He called attention to the fact that when we try to recall anything that is not at the moment in the mind we think of something that is similar, or opposite, or something that has been associated with it in time, or space. The English empiricists developed these principles into the traditional "laws of the association of ideas." They are the laws of similarity, contrast, and contiguity in time or space. An idea calls up another idea because it is similar to it, or because it contrasts with it, or because it has been connected with it in time or in space. Since that time these four laws of association have been reduced to two: the law of similarity and the law of contiguity. The tendency of many modern psychologists is to make a still further reduction. They assert that all cases of associative recall may be placed under the law of contiguity.

**The Laws of Association.**—The so-called laws of association have been looked upon as an explanation of associative recall, rather than as a statement of the facts of recall. For instance, according to the law of similarity, one thing was supposed to recall another *because* of the similarity between them. Now, the statement that one idea recalls another because it is similar to the idea recalled, and the statement that a similar idea is recalled are two entirely different statements. It might well be that similar things tend to be recalled together, and yet the similarity may not be the cause of the recall. We shall return to this point later.

It is also true that the laws of association have been concerned with the recall of associated ideas and not with the formation of associations. It is evident that the process of forming associations and the process of recalling associated ideas after the associative connections have been formed are different processes. And, further, the reason for forming the associations may not be the reason why the associated ideas are recalled. To this point also we shall return.

**Contiguity.**—Accepting the prevailing theory that in the law of association we may find the explanation of associative recall, we incline to the belief that a single law—*the law of contiguity*—will cover all cases of associative recall. This law may be stated as follows: Objects or events which have been experienced together, will be revived together whenever any member of the group is present in consciousness. Any member of an associated group of experiences tends to awaken the other members of the group. Here again psychological language is figurative to a high degree. We often say, for instance, that one idea has an attraction for, a tendency to suggest, the ideas which have been associated with it. What is really meant is that the neural process involved in the given idea tends to spread to other centres which have been excited on former occasions at the same time.

Now, since any given object, event, or idea, has been associated with many different things in the past, the general law of contiguity is not specific enough to explain why one, rather than another of these past associates is recalled. We may narrow the problem by saying that the idea which is most closely associated will be recalled, or in neurological terms, the liability of the given mental content to bring to consciousness one rather than another of its past associates is determined by the permeability of the brain pathways connecting the brain centres. The neural impulse will follow the most permeable pathway. But to say that the most closely associated idea will be recalled is proceeding in a circle, unless we can describe the conditions which determine the "closeness of association." We have touched upon this point in discussing associative recall in memory. We found that the operation of the law of association is modified by several conditions. For instance, the closeness of association may be determined by any one, or by several of the following conditions: Recency, frequency, and vividness of the associated experiences; the context of thought in the mind at the time, and the dominant plan or purpose uppermost in the mind. While these conditions determine the direction of associative recall, the general fact remains that any given mental content always recalls something that has been formerly experienced with it. This is the law of contiguity.

**Similarity.**—Now, it may be objected that the so-called association by similarity is an exception to the law of contiguity—that an idea is often recalled because it is similar to something we perceive or to something that we may be thinking of at the time. And, further, it may be said that it is a common occurrence to have some presentation or idea in the mind call up an idea which has never been experienced previously with it. For example, I may meet a stranger whom I have never seen before and immediately I think of a friend. Here apparently is a case of recall where the mental contents have never before been experienced together. To explain such cases, the law of similarity has been evoked. And so it is said that the stranger reminds me of my friend because of the similarity existing between them. If, however, we wish to explain psychologically why I thought of my friend when I saw the stranger, we could make no greater blunder than to assign similarity as the cause of the recall, for the similarity appears in my mind only after the recall has taken place. Instead of the sequence: (1) sight of the stranger, (2) consciousness of similarity to a friend, (3) thought of my friend, what we really have is: (1) sight of the stranger, (2) thought of my friend, (3) consciousness of the similarity. It is evident that similarity arises only when the two terms compared are already in consciousness. But what we are seeking is some principle to explain why, given the first term, the second term appears. If we analyze the situation more closely, we shall see that this principle is the principle of contiguity after all. While the stranger as a total experience has never been associated with my friend, some part of him has. It may be the shape of his nose which is identical with that of my friend's. This particular shape of nose is a part of my friend's make-up which I have experienced in connection with all his other characteristics many times. So when I meet this feature of my friend in the stranger it recalls its former associates. It is plain that what occurs in cases of so-called association by similarity is that some feature of the present object attracts the attention, and "breaking away from its immediate associates, gathers to itself certain of its former associates which combine therewith to form the new object of thought."[1] Judd[2] uses the following diagram to illustrate association by similarity.

[1] James: "Principles of Psychology."
[2] "Psychology," p. 235.

Now, while we may say that any experience tends to call up similar experiences, we cannot, however, explain the recall psychologically by the principle of similarity. Therefore the law of association by similarity holds only as a statement of fact and breaks down as a psychological explanation of association. It is true that similars recall similars,[1] but it is not the consciousness of their similarity that brings about the recall.

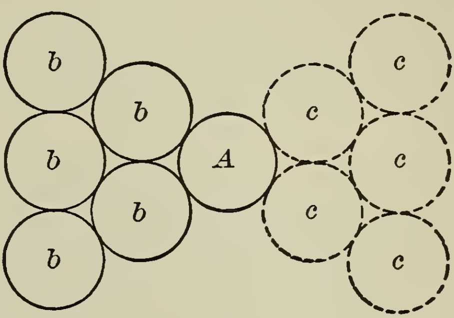



FIG. 70.—To apply this figure to the case cited: The circle *A* represents a single feature (the shape of the stranger's nose); *b*, *b*, *b*, etc., represent his other features. In my past experiences *A* has been a part of another system (the features of my friend). When *A* attracts my attention, it breaks away from its present *b*, *b*, *b*, etc., and revives its old associates, *c*, *c*, *c*, etc.

It is plain that when we perceive similar things the fact that they are similar attracts attention. For this reason they become associated, and afterward the one will recall the other, because of the principle of contiguity. Similarity is therefore one of the principles or conditions for the *formation* of associations, but is not the explanation of associative recall. Any relation between things or ideas serves to attract the attention and, consequently, becomes the condition for the formation of associations. The relation of contrast, cause and effect, and the spatial and temporal relations, together with similarity, are favorable conditions for associative

[1] We might even say that objects and events are recalled because they are similar to objects and events perceived or thought of. But when making such a statement, we must understand that we are making physical and not psychological descriptions. I might say that it was because my friend is similar to the stranger that I think of him. This, of course, is true in so far as I am merely pointing out physical traits. It is because the two *physical objects* have the same character that the consciousness of the one is followed by the consciousness of the other, but this is quite different from saying that the consciousness of the one is followed by the consciousness of the other because of the consciousness of the similarity.

formation. They serve to hold mental states together in the focus of attention until the associative connections are formed. But the psychological conditions present during the formation of associations may not be present during recall. I may, therefore, be attracted to two objects or events because they are similar, or because one contrasts with the other, or because one is the cause or the effect of the other. But during the process of recall these relations do not enter into consciousness.

We are, therefore, brought back to the law of contiguity as the law of association. Even this law does not explain associative recall psychologically. Psychologically, it is only a statement of facts. There is no psychological reason why mental states that occur together should be recalled together. The real reason will be found in the neural processes back of the mental states.

**Partial and Total Recall.**—There is then no difference of kind between the so-called associations by similarity and associations by contiguity. Both make use of the same principle of recall—contiguity of experiences. There is, however, an important distinction. In one the contiguity is hidden and in the other it is superficial and plainly evident to observation. When a given experience as a whole calls up experiences that have been associated with it, the connection is evident, but when only part of a given experience is active in bringing up its past associates, the connection is hidden. In the latter case, the given experience is analyzed or broken up into constituent elements, one of which has been connected with some former experience and for this reason calls it up. In the former case the given experience acts as a whole and therefore calls up only those experiences which have been associated with it in its totality. The so-called "association by contiguity" is therefore very much limited in scope. The distinction is the distinction that we have already made between *partial* and *total* recall. Association by similarity is simply a case of *partial recall* and occurs when the present contents of consciousness are analyzed and evaluated and the pertinent elements used as connecting-links for the next idea. Not only are the threads of thought multiplied many times in this form of associative recall, but the subtle and delicate identities of thought are brought to light. This type of recall characterizes the great thinker. Hamlet's soliloquy furnishes an excellent illustration of the subtle and hidden association of ideas. On the other hand, mere surface contiguity calls out trains of mechanical associations. This form of recall—total recall[1]—is illustrated on page 250.

**Falsification of Association.**—Where associative connections are not firmly fixed, suggestions given by others may falsify the nature of the associations. Such falsification of association is especially manifest in children when they are being questioned about actual events which they have witnessed. If the questions have suggestions in them, the force of the suggestions may modify the actual connections made in the child's mind, so that he is unable to give a correct report of what happened. Persons of weakened mentality or even the normal individual when fatigued or excited during long examinations may, by skilfully arranged questions, be led to give false testimony in court. In certain cases, questions which presuppose a certain answer—leading questions—or questions which demand the answer which they suggest, will actually set up associative connections in the mind of the witness, causing him to give false testimony. We have already referred to this in our treatment of memory. Those who wish a discussion of this phase of the subject may read Münsterberg's "On the Witness Stand," or Whipple's article "The Observer as Reported: A Survey of the Psychology of

[1] Usually three degrees of activity in recall are distinguished: (1) Total recall, (2) partial recall, and (3) focal recall. *Total recall* embraces those cases where the whole of a present thought is active in recalling the next thought, *partial recall* where a part only, and *focal recall* where some single element or feature is active in recall. *Focal recall* is, however, simply an extreme case of *partial recall.*

Testimony."[1] An excellent German work treating of this subject is Stern's "Beiträge zur Psychologie der Aussage."

Association Tests.—Individual differences in the character and rapidity of associations may be studied by means of very simple association tests. In general, the more nearly alike the surroundings and past life of individuals, the more their associations will be alike. For instance, if we should give the same list of stimulus words to members of the same family, asking each to respond with the first thought that comes to mind when he hears the stimulus word, we should find a striking similarity in the character of their associations. This is to be expected from the nature of associative connections.

There are several forms of association tests. We may ask the subject to pronounce a large number of words just as rapidly as he can think of them. He then starts with any word he wishes and pronounces the words as fast as they arise in his mind until stopped by the experimenter, who has noted down the words and recorded the time of the associations. Such associations are termed (1) *uncontrolled associations.* Or we may place a restriction on the character of the associations to be given, in which case the associations are termed (2) *controlled associations.* Three forms of the controlled associations have been used very widely: (*a*) Part-whole, (*b*) genus-species, and (*c*) opposites. In the part-whole test, a list of stimulus words, printed on a slip of paper, is handed to the subject who has been instructed to name the whole thing of which each word is a part. The total time required to make the associations is recorded together with the responses. Thus, if a stimulus word is "door," the subject must respond with the name of something of which "door" is a part, as "house" or "barn" or "building."

In the genus-species test, the procedure is the same, except that the subject is required to respond to each stimulus word by the name of something which belongs in the class

[1] *Psychological Bulletin*, vol. VI, pp. 153–170, May, 1909.

indicated by it. For example, if the word "tree" is given, the response must be some kind of tree, "maple-tree," or "apple-tree" or "oak-tree," etc.

The opposite-test requires that a word which means just the opposite of the stimulus word be given. To the word "bad" the subject must respond by the word "good," to "sane"—"insane," to "high"—"low," and so on. The number of stimulus words may be varied at will, but in each case the time and the character of the responses must be recorded. In the part-whole, genus-species and opposites, the associative responses are controlled or restricted by the set of the mind given by the instructions just before the test. In the uncontrolled associations there is no such restriction.

The associations are still uncontrolled when the subject is given a list of stimulus words and he responds with any word that comes to his mind. The experimental study of associative connections may be carried on for a number of purposes: To investigate the individual differences in the thought content and thought processes as conditioned by sex, age, training; to determine the effect of fatigue, drugs, etc., on the associative recall; to diagnose abnormal mental disturbances and to detect hidden mental tendencies and wishes or intentionally withheld information.[1]

Since the formation of associations depends upon original experiences, it follows that the character of associative connections is a clew to the nature of the original experience. If ideas call up the ideas which have been connected with them, one's past must necessarily be revealed by the character of his ideas. If we should ask a number of persons to give the first idea that comes into mind when a stimulus word is pronounced, their different associations would, in most cases, reflect some feature of their past. For instance, in a list of stimulus words given to a class in psychology was the word "Becky." Eight members of the class responded to the

[1] For a description of association tests, see Whipple's "Manual of Mental and Physical Tests," 2d ed., pp. 409-455.

word by "Grand," three by "Frances Starr," and the rest by scattered associations. It turned out that twelve members of the class had the week before witnessed at the Grand Opera House a play entitled "The Case of Becky," in which Frances Starr played the title rôle. Of the twelve, all but one indicated by their associations the fact that they had seen this play.

James quotes an anecdote from Professor H. Steinthal[1] which illustrates the fact that the character of our associations are clews to our past. The substance of the anecdote is as follows: Six strangers found themselves in the compartment of a railway-carriage. One of the party undertook to name the occupation of each member of the party upon the condition that each answer a simple question. They all agreed, whereupon he wrote a question upon five slips of paper and gave one to each of his companions with the request to write the answer below. When the leaves were returned, he read the answers and without hesitation said to the first, "You are a man of science"; to the second, "You are a soldier"; to the third, "You are a philologer"; to the fourth, "You are a journalist"; to the fifth, "You are a farmer." All admitted that he was right. When the stranger left the railway-carriage they compared notes and discovered that he had written the same question upon each slip of paper. It was: "What being destroys what it has itself brought forth?" The naturalist had answered, "Vital force"; the soldier, "War"; the philologist, "Kronos"; the journalist, "Revolution"; and the farmer, "A boar."

We may not only study the character of association, but we may measure the time required to recall an association word. When a stimulus word is pronounced, it requires a certain length of time before the subject can think of an association word. If the word "day" is given, the subject may respond with the word "night." If we measure the time between the giving of the stimulus word and the re-

[1] "Einleitung in die Psychologie u. Sprachwissenschaft," p. 166.

sponse, we shall find that the association time varies for normal associations from one to two seconds. But under certain conditions there is a marked lengthening of the time. If the stimulus word arouses an emotional complex, or if the subject does not give the first association for fear of "giving himself away," and hunts for another association, the association time is lengthened. Therefore, both the character of an association and the time required to form the association are significant in detecting past experiences. To illustrate: The following test was made upon four students in psychology for the purpose of detecting which one of the four had read a certain article in the morning paper, which only one had seen. The procedure was as follows: The four students were left alone in a room. One of them read the following article, but which one the instructor did not know.

## SPOT ON MONUMENT

### Causes Washington People to Believe "Human Fly" is Busy

Washington, May 7.—Rumors that a New York "human fly" who has been scaling the office buildings here was climbing the side of the 555-foot Washington Monument gave the city no end of excitement to-day. Some one suddenly discovered a black spot on the side of the shaft about 150 feet from the top, and then the report started.

Hundreds of people rushed to the monument grounds. Along Pennsylvania Avenue crowds collected at every corner, and windows and doorways rapidly filled with people. Investigators said that the supposed spot was only a spot left by the rain.

The War Department, which controls the monument, was besieged with telephone calls. Nearly three hours after the first explanations a telephone message from the Capitol said the legislators were watching the spot through opera-glasses and were convinced that it moved occasionally.

A list of fifteen stimulus words (the words in column (1) of Table I), in which six "dangerous" words were placed—*opera*, *spot*, *human*, *climb*, *fly*, *Washington*—was prepared. The four students were then given this list separately. Their responses and association time were taken and are given in the table. The subjects are designated by the letters *B*, *M*, *W*, and *C*. *B* gave the responses in column (2), *M* in column (3), *W* in column (4) and *C* in column (5).

TABLE I

| STIMULUS WORDS | RESPONSES | | | |
|---|---|---|---|---|
| (1) | (2) B | (3) M | (4) W | (5) C |
| 1. Summer | winter 1 | winter 1 | winter 1 | winter 1 |
| 2. Opera* | play 1 | singing 1 | house 2 | music 1 |
| 3. Day | night 1 | night 1 | night 1 | night 1 |
| 4. Spot* | *blotch* 1 | black 2 | board 1 | piece 1 |
| 5. Table | desk 1 | chair 1 | legs 1 | cover 1 |
| 6. Human* | man [5] | life 4 | men 1 | divine 4 |
| 7. Come | go 1 | go 1 | go 2 | go 2 |
| 8. Climb* | mountain [3] | crawl 1 | tree 1 | tree 2 |
| 9. Window | door 1 | shutter 2 | glass 1 | cushion 1 |
| 10. See | land 3 | bay 2 | water 1 | ocean 2 |
| 11. Tie | collar 2 | red 2 | road 1 | knot 2 |
| 12. Fly* | wasp [4] | bird 1 | wings 1 | bugs 1 |
| 13. Book | ledger 2 | paper 2 | leaves 1 | ...... |
| 14. Washington* | Jefferson [3] | Lincoln 1 | capitol 1 | D.C. 1 |
| 15. Sour | sweet 1 | sweet 2 | bitter 1 | sweet 1 |

The dangerous words are marked in the table with an asterisk. The numerals in columns (2), (3), (4), and (5) represent in seconds the association times for each response. The time was taken with an ordinary stop-watch, since the test was made only for rough demonstration purposes. For more exact laboratory work, the time may be taken in hundredths of seconds.

Subject *B* was correctly designated as the guilty person by the results of the tests. He passed two of the dangerous words without lengthening the time of reaction. But when he came to "human," his first association was "fly," but since that would have indicated his acquaintance with the article just read, he did not give it. It required several seconds to change the association word to "man." Therefore his association became "blocked." Sometimes it occurs (not shown in this test) that the blocking of an association will be delayed and appear in the associations immediately following a dangerous word which the subject passes successfully. This takes place where there is more at stake than in the demonstration test just given. What happens in such cases is that an emotional disturbance started by the dangerous word requires time to develop, and therefore shows its effect in later associations.

Attempts have been made to apply association tests to suspected criminals for the purpose of detecting their familiarity with places and events connected with crimes.[1] The association method has also been used in the diagnosis of cases of hysteria and neurasthenia. It is supposed that such mental affections are due to certain past experiences of highly emotional character which have been repressed and submerged in consciousness. The patient either desires not to give expression to, or has half-forgotten these experiences. In either case, they are nevertheless constant sources of mental disturbances. By giving long lists of words properly selected, the physician is able to detect those which show abnormal associations, and so indicate that they have "tapped" the emotional complexes in the patient's mind. In this way it is often possible to discover the nature of the mental disturbances—to uncover the experiences which have been disturbing the mental equilibrium of the patient. Past experiences which lie at the bottom of hidden and unexpressed desires, secret worries, and divergent or antagonistic tendencies which are the beginning of mental dissociation are brought to the surface of consciousness by arousing suppressed associations. Such associations may reach back to the early life of the patient, even to the years preceding adolescence. It is here that Freud has rendered important service to abnormal psychology through the method of psy-

[1] See Münsterberg's "On the Witness Stand"; also lectures given by Jung at Clark University, on "The Association Method," *American Journal of Psychology*, XXI, 1910, pp. 219–270.

cho-analysis. This method supplements the association method by seeking through a series of questions to draw out the patient and induce him to give full expression to the suppressed or half-forgotten experiences, which nevertheless preserve subconscious associative connections with the present conscious life. When these associative connections are re-awakened, the unity and equilibrium of consciousness is restored.

An interesting phase of Freud's theory is the importance he attaches to dreams as clews to hidden experiences, suppressed desires, and wishes. He believes that in many cases dreams are symbols of the wishes which we do not allow ourselves to express in waking moments. A careful analysis of our dreams will often enable us to determine what these suppressed wishes are.

The work of Jung and Freud has done much to demonstrate the fact that associative connections once formed are not entirely lost, even though we may not under normal conditions be able to recall them. The threads of past associative bonds may remain and exert a much more powerful influence on our mental life than we ordinarily suppose. Experiences which we have forgotten may play a part in determining the course of our thought and action. No matter how much the individual may wish to shake loose the bonds which connect him with his past experiences, or how successful he has been in putting them out of his thoughts, their impress has been left upon him, and is, therefore, a component element in the underlying strata of his character.

**Physiological Basis of Association.**—We may easily form some conception of the neural mechanism involved in the associations which are set up between presentations and the motor responses which we make to them. In such cases, the nervous impulses aroused in the sensory centre discharge into motor centres and pathways. We have already seen that this discharge of sensory centres into motor pathways is a general characteristic of the central nervous system. In a large number of cases, the particular motor response that becomes associated with a given presentation is one that has been gradually selected and stamped in because of its fitness in adjusting the individual to the presented situation. The particular motor response is, therefore, the successful one of the many responses that were, from the beginning, natively associated with the given presentation. Such is the method of learning motor responses by trial and error.

But when we ask how one presentation comes to be associated with another presentation, as is the case in association by contiguity, the problem set for physiological psychology is much more difficult than is the case where one term of the association is a motor reaction. When, for instance, the child sees a horse for the first time and hears the word pronounced, how does the visual centre, corresponding to the sight of the horse, come to be connected with the auditory centre, corresponding to the sound of the word, so that afterward the one arouses the other? In the first instance, each centre is aroused independently of the other. Is the mere fact that they are active at the same time sufficient explanation for the fact that a neural pathway is opened between the centres, so that when afterward the child sees a horse, the word comes to the mind, or when he hears the word the visual image of the horse comes to mind? At present, physiology cannot answer the question, so we shall have to accept the most reasonable theory. McDougall[1] proposes the drainage theory to account for the formation of neural connections. According to this theory, when the child sees the horse, his visual centre is excited, then he hears the word "horse" and his auditory centre is excited. The attention shifts from the visual appearance of the horse to the sound of the word. Accordingly, the activity aroused in the visual centre is drained off by the auditory centre. Thus a neural pathway between the two centres is formed.

[1] "Physiological Psychology," p. 126.

Ladd and Woodworth[1] are of the opinion that the drainage theory does not explain all cases of association by contiguity and, further, that in some cases where complete drainage between centres could very well take place, no associative connections are formed. Such cases are found, for instance, in the shifting of the attention in the staircase or bent cardboard figures. Here attention shifts from one aspect of the figure to the other, affording a splendid opportunity for the drainage of one centre by the other. Yet there is, so say these authors, no evidence of the association between the two perceptions of such figures. They agree that in the formation of associative connections nerve currents must pass between the different centres involved. But it is not the mere drainage of one centre by the other that sets up the associative connections. It is not the shifting of attention, but the movement of attention with anticipation or expectancy of something to come, with a lingering of what has just gone. In neural terms, this expectancy corresponds to a damming up of energy in the first centre until the expected stimulus comes; then it discharges into the centre aroused by the stimulus. Illustrating the formation of association between the visual appearance of a new acquaintance and his name, these authorities say: "If one says, for example, 'Let me present Mr. A,' the nervous energy aroused by the sight of the man is perhaps held in check till the name is spoken, and then discharged into the centre aroused by the auditory stimulus which, on account of its being aroused by this stimulus, would the more readily attract other nerve-currents having a partially open path into it. Such a condition would account, also, for the special clearness with which an expected stimulus is perceived."

[1] "Elements of Physiological Psychology," pp. 617–625.

# CHAPTER XIII

## CONCEPTION

**Thinking.**—In perception and imagination we have treated only that aspect of consciousness which is concerned with separate and particular things and events. But consciousness includes more than the perception or the imagination of discrete things. We are never aware of an object without involving more than the object itself. An object is always presented in some context—in some relation to other things. The pen that I now see is not just a pen. It is a pen *writing*—*my* pen—the pen that *I bought yesterday*—a pen *made of steel*—etc. I am more or less conscious of these relations when I image or perceive the pen. I not only see the book, but I am conscious of it *on* the table *before* me—as *belonging to my friend*—as *written by Holmes*. The consciousness of these relations is just as much a mental content as the consciousness of the presented object. It is the consciousness of relationship which binds the discrete elements of our mental life together. Sometimes our attention is fixed chiefly upon the sensory appearance of the object and sometimes upon the relations. When we attend primarily to the relations between things, we employ a phase of consciousness which we have not yet discussed. This form of conscious activity is *thinking*.

Thinking is the manipulation of data given in sensation, perception, and imagination in such a way that the relationships existing between things are actively attended to.

The consciousness of relationship is implicitly present in all forms of consciousness, save perhaps in the so-called pure sensations. Perception, for instance, cannot take place without recognition of the object perceived and recognition is the implicit consciousness of the relation of sameness or identity. There is also present in the perception of an object, the relations which the object bears to other things. Sometimes the emphasis is placed upon the sensory presentation of the object, while relationships occupy the background of consciousness. In thinking, on the other hand, the consciousness of relationship comes to the front and is made the bridge over which we pass from one discrete element of thought to another.

Can we be conscious of things without their relations? Theoretically, the "pure sensations" (the hypothetical first sensations), if they exist, involve no consciousness of relationship. One might suppose that the baby's first consciousness is a mass of vague, unrecognized experiences—that his first sensations of cold and warmth, of pressure and taste, are bare disconnected mental flashes of sensory contents not related in any way in its consciousness. But, even here, our earliest observation of the child shows that he does relate his experiences. When he sees his mother, nurse, or bottle, there are unmistakable signs that he experiences, although perhaps dimly, a feeling of familiarity which may be characterized by "this-is-like-something-I-have-experienced-before." Whether we look upon this primitive and simple relational experience as a rudimentary form of thinking or not, it cannot be doubted that the thinking process is founded on this faint awareness of sameness or identity. James says: "A polyp would be a conceptual thinker if a feeling of 'Hollo! thingumbob again!' ever flitted through its mind."

Thought then adds to the bare perception of individual things the consciousness of relations existing between them, thus organizing and unifying and rendering intelligible what would otherwise remain isolated and chaotic in consciousness. There are three aspects of the thinking process—*conception*, *judgment*, and *inference*. These aspects are intimately related and interwoven and really belong together. We shall, however, treat them in separate chapters.

**The Concept.**—As we said, in perception, imagination, and memory, consciousness is concerned with individual and particular things. We perceive, or image, or remember this particular object, or that particular event. In short, in perception and imagination we are always dealing with a world of particular and concrete experiences. We have, for instance, known a number of individual horses and we can form an image of any one of them, more or less perfectly. If we were obliged, however, to image all these individual horses when we wish to think or speak of them, we could make very little progress in thinking or in communicating our ideas to others. Such a method would be a very cumbersome way of making use of past experiences. If we were content, when thinking or speaking of horses, with the image of a single horse, the thought would be a poverty-stricken and fragmentary representation of what we really know of horses, and anything we could say about them would be very much limited in scope.

What we need for the purposes of thought and the communication of knowledge is some form of consciousness which will consolidate the essential elements of our past experiences with similar objects into a single mental content which comprehends all of them at once. Happily, this need is supplied in the *concept*. The concept is the mental state which comprehends a number of particulars possessing a common element or group of qualities in a single mental content. For instance, the concept horse refers to all horses and attaches a common group of qualities to each member of the class. The concept John Jones refers to all the different particular aspects of an individual. The concept is therefore general and not particular in its reference. It refers to all the members of a class, or to all the different aspects of a single object and emphasizes a common or universal quality which is taken to be the same throughout a variety of instances.

The conscious states which comprise our thoughts of horse, wood, dog, tree, London, John Jones, truth, honesty, etc., are concepts. We mean by horse any horse whatsoever, or the common qualities of all horses; by London, all its different parts and aspects; by honesty, the essential character of all honest acts; and not *this* horse, or *this* aspect of London, or *this* concrete act of honesty.

**The Formation of the Concept.**—The formation of the concept involves, either explicitly or implicitly, the process of abstraction and generalization. After the reflective processes have developed, we may re-form our old concepts or form new ones according to logical laws. We may then, with the avowed purpose of forming a correct general notion, *observe* each individual case of a class of objects, *analyze* each into its elementary qualities, *compare* the different cases, *abstract* the common qualities, and then *generalize* them into a concept. This is the logical formula for getting at the universal character of things. But nearly all our concepts grow up unreflectively out of our every-day experience with things and do not, therefore, follow this formula. Concepts begin in the hazy ideas of childhood and only slowly assume their present character. In the unreflective formation of concepts the abstraction and generalization of common qualities of a class of like objects is not the result of an explicit reflective process, but is implicitly impressed upon us chiefly because the individual objects of any given class call out the same reactions. The way we react to individual objects is the most potent factor in our early classification and definition of things. Because we react in the same way to different individuals of the same class, we come to think of them in the same way—to discover and emphasize the same qualities in them. For instance, we react in the same way to all individual chairs, tables, horses, etc., and so come to think of each class in the same terms. At first children define entirely in terms of use, or we may say in terms of their characteristic reactions to the things defined. Thus, chair is "something to sit on," table is "something to eat on," horse is "something to ride or drive."

Their first notions are, therefore, determined by their reactions.

**The Psychological and the Scientific Concepts.**—The concepts which have grown up gradually in our perceptual and unreflective experience are called *psychological concepts*, to distinguish them from the concepts which are the result of reflective thought, in which the processes of comparison, abstraction, and generalization are purposely instituted in order to determine the exact nature of things. Concepts formed in this way are called *logical* or *scientific concepts.* They are termed "*logical*" because they are the product of a more or less formal logical procedure, and "*scientific*" because they are attempts at exact formulation and definition of meanings.

Very few people can satisfactorily define water, air, table, truth, because they have never subjected their experiences with them to reflective observation and analysis. They are unable to point out the universal and distinguishing qualities of these common things. Yet we all have a good working notion of them, which has been gained in every-day experience, and which serves our practical purposes. The logical concepts are, however, superior instruments of thought and action. The man who has carefully and logically thought out the nature of things and has explicitly formulated their meanings so that he knows exactly what they include is better able to control them. Any farmer has a practical notion of trees. His concepts of elm, oak, hickory, ash have been gained through an extended practical experience, yet he is not able to take a position in the government horticultural service. His concepts of apple, peach, and plum are as complete as ordinary perceptual experiences can make them, yet he cannot compete with the student from the horticultural department of the College of Agriculture in handling an orchard.

The psychological concept, however, is the basis—the first stage in the development of the logical concept. Unreflective generalization gives us our first notions of things. Reflective thought refines and defines them into logical concepts.

**The General and the Individual Concept.**—If we consider the intrinsic nature of the concept instead of the manner of its formation, we find two forms: the *general* and the *individual concept.* The general concept is that mental state which refers to all the members of a class of objects having a common quality or group of qualities. Thus, "man" is a general concept. We mean by man every member of the class and to each member we attribute a universal group of qualities.

The individual concept is that mental state which refers to all the different aspects of a single object. Thus, the mental state which corresponds to "John Jones," is an individual concept. John Jones, as an actual, concrete existence, has many different states, qualities, and activities. I have, for instance, met him in society, in business, on the golf-links, in the club, etc. No single image of John Jones can represent him in all his totality. The concept, "John Jones," on the other hand, consolidates all his states, qualities, and activities, as I have known them, into a single mental content. When I think John Jones, I do not mean John Jones in particular, but John Jones in all his aspects. Just as in the general concept "man," I mean all the different individuals of a class, so in the individual concept John Jones, I mean all the different aspects of his existence. By the general concept we think the same quality in a number of different individuals; by the individual concept, we think the same individual in a number of different qualities.

The individual concept involves abstraction and generalization quite as truly as the general concept. In forming the concept John Jones, we isolate the qualities which belong to John Jones and mark them off as distinct from those of other men. We generalize when we think John Jones in all these different aspects.

**The Analysis of the Concept.**—So far we have spoken only of that which the concept does, its functional aspect. We have said that it refers to all the members of a class, or to all the characteristics of an individual. We must now inquire into the nature of the concept itself, its structural aspect. Of what kind of "conscious stuff" is the concept made? The answer to this question will show us how a single mental state "refers to," "comprehends," or "consolidates" a number of particular objects and particular qualities into a mental unity.

If we examine carefully the content of any concept, we shall find two constituent elements in it: (1) The image and (2) the consciousness of meaning. For instance, at the moment I think "horse," the content of my consciousness is made up of an image of some kind and a definite core of "horse meanings."

**The Image.**—The image may be either concrete or verbal. In the case cited, the image may be either the concrete visual image of some particular horse, or the visual, motor, or auditory image of the word "horse." Any one of these images may serve as a means of attachment for the meaning implied in the concept. When I think of horses in general, I sometimes find myself entertaining a rather indefinite, hazy, visual image of a horse. Sometimes the sound of the word "horse," together with the feelings of enunciation, as though I were about to pronounce the word, "horse," arise in my mind. Now, in the first case, the image is a copy image. In the second case, the word image is purely symbolic. It serves as a symbol of the things I am thinking about. It is safe to say that the word image is most commonly used in the concept.

In cases where the visual image of some particular horse arises in my mind, I do not intend or mean the particular horse imaged, but the whole class of horses. It is perfectly possible for concrete images to function in this way. In fact, all imagery must, in order to function in a concept, be symbolic, *i. e.*, stand for or signify something beyond itself. No image can copy all the varying sizes, forms, and colors of all the individual horses I have known. Nor is it necessary for the image to be *like* the things it stands for, any more than the sign of a grocery store needs to be like the store itself. An image may stand for something beyond itself, even though it is not like it.

The mistaken assumption that images must resemble the things they signify has led some writers to deny the possibility of general ideas. They assert that only ideas of individual and particular things are possible, for it is impossible to form a general image. Locke contended that a general idea of a triangle is impossible, because no single image could picture all forms of triangles. But he neglected the fact that the image of any particular triangle may mean or signify all other triangles.

Certain psychologists, still believing that the image must correspond to the thing it signifies, proposed the theory of the *generic image*. The generic image is supposed to be a "general image"—a composite of all the characteristics of the particular individuals in a class—a composite photograph, so to speak. Accordingly, the generic image is thought to have a "distinct and salient centre or core corresponding to the common characteristics of a class, together with a vague and inconstant margin corresponding to the variable characters of the individuals composing the class."[1]

The generic image, therefore, is a form of the copy image, but as such it is wholly inadequate, as we have pointed out. What would be the character of the generic image of color? The writer has never been able to observe a generic image in his own consciousness. Hazy, sketchy, and indistinct images of some particular object, or images constructed out of the re-presentations of parts of different objects of the same class, he has, but such images are not generic images.

[1] Baldwin's "Dictionary of Philosophy and Psychology," article on Generic Image.

After all, the generic image is not necessary. Any image can be the bearer of meaning. Most of the images we use in thinking are verbal images and they bear no resemblance to the things they stand for. We have already seen in the chapter on imagination that there is an increasing tendency to give up concrete copy images and use word images instead.

Not only images, but also perceptions may serve to signify meaning. The perception of a certain shell may in the geologist's mind signify the characteristics of a whole geological age, provided his attention is centred on its meaning and not on its sensory appearance.

**Consciousness of Meaning.**—The important part of the concept is *consciousness of meaning*. When we see or hear the words "chair," "table," "book," we understand what they mean, although we may not consciously re-present any one of the concrete things named. The content of consciousness is, in each instance, made up of the word and its meaning. If, on the other hand, we should see or hear the words "elbat," "koob," "riahc," we do not understand them. There is practically no consciousness of meaning, nothing but the sensory aspects of the words.

Whenever an image or percept stands for, signifies, symbolizes something that is not present as a sensory content, the "*standing for*," "*signifying*," "*symbolizing*," is consciousness of meaning. The word "book" arouses a definite group of meanings, which are marked off in the mind from all other meanings. The word "dog" arouses a different group. And so each symbol of meaning turns consciousness in a certain direction, and gives an added content to consciousness. This content (meaning) cannot be described, for it does not exist in sensory terms, but rather in terms of relation. That it is a conscious content which gives a determining character to the concept may be shown in various ways. For instance, suppose I should pronounce the word "bear." Your mind is turned immediately toward a class of wild animals. But suppose that, while this meaning is hanging in your mind, I add the words "your burdens cheerfully"; you would then know that you had aroused the wrong meanings. A mental shock, accompanied by the feeling that the animal meaning is not appropriate would follow. You would then, while the words ("your burdens cheerfully") were still upon my lips, change the meaning—turn your mind in the proper direction. This experience would be impossible if consciousness of meaning were not a definite mental content.

Now, we have already seen that no moment of consciousness, with the possible exception of the pure sensation, is absolutely isolated and free from meaning. All experience is interwoven by the threads of relationship. Everything experienced suggests the relations it may have to other things and to other aspects of its own existence. For instance, the momentary perception of one aspect of the penknife (its appearance as it lies on the table) means all the other characteristics of it not now presented, because I recognize the knife as the same throughout its different aspects. Or it may mean for me all other individual members of its class, because I recognize a certain group of characteristics as the same in a number of different instances. In the one case, the concept is individual and in the other general. The important point to be noted is that in either case consciousness of meaning is based upon the relations which exist between the parts of our conscious life. When attention is directed toward the relational connections which a thing or its image has, instead of upon the thing itself, we are conscious of meanings. The definition and organization of these meanings into distinct units which mark off classes of objects is the formation of the concept.

**The Intension and Extension of Concepts.**—The definite group of meanings which a thing or term has for us is known as its *intension*. For example, the meanings which are comprehended by the concept "horse" constitute its intension. The use of this meaning to mark off a single group or class of separate objects constitutes the *extension* of the concept.

Thus, the application of "horse meaning" to all individual members of the class "horse," constitutes the extension of the concept. The definition of the concept consists in setting out clearly the meanings which are embodied in it, *i. e.*, in making its intension explicit. It is plain that as the extension of a concept increases, the intension is restricted. The intension of general concepts is much more restricted than is the case in individual concepts. The meanings which we can apply to a number of different individuals are fewer than those which we apply to a single individual.

**The Genesis and Development of the Concept.**—The beginning of the concept is laid in perception. Just as soon as a presented object begins to suggest qualities and attributes not actually presented to the senses, it begins to function as a concept. The growth and development of the concept continues just as long as we continue to get new experiences from the object. After we have experienced an object many times and have come to know its various aspects, any single presentation reveals not all of the object as we really know it, but a single aspect of it. All its other aspects are either ignored and attention given to the object's sensory character at the moment, or they are given as meanings. If attention is placed upon the presented sensory content, while the meanings occupy the background of consciousness, the mental state is perceptual. But if the presented object itself is a secondary consideration and we become intent upon its meanings, then the mental state is conceptual. For instance, on the mantel in my study there is an old Pompeian lamp. If, as I look at it, my consciousness is confined to its form and color, the material of which it is made, and the figures carved upon it, my consciousness is perceptual. But if when I look at it I feel the tug of a hundred thoughts concerning it and the fated city it represents, striving to rise to full consciousness, then the presented object is merely a symbol for a whole troop of meanings, and it really functions as a concept. If we could follow the development which the consciousness of this object has undergone in my mind, we should have the history of the development of an individual concept.

Hand in hand with the development of the individual concept goes the development of the general concept. We not only learn to know a single object in all its various aspects, but we also learn at the same time what characteristics are common to all the members of the group to which it belongs, and thus we form the general notion. We should note that these two processes go on together, that the individual notion and the general notion develop at the same time—that as we meet different individuals of the same class we discover more and more the particular characteristics of any single individual, and as we discover new characteristics in the individuals, we learn more about the class as a whole.

It is sometimes assumed that our general concepts originate only as a result of that logical process of thought which starts with a number of particular objects, analyzes and compares them, abstracts the common qualities and generalizes them into the concept. The origin of the child's concept of lamp would, according to this assumption, first involve the acquaintance with a number of individual lamps and require that he should then compare, abstract, and generalize before he has any notion of lamps in general. This is a false assumption. What really happens is quite different. In his first experiences with a single lamp the child will be attracted by some striking characteristic (its light-giving quality). This immediately becomes a general notion which he uses to interpret other cases. For instance, he may call the moon a lamp. He, therefore, generalizes from the very beginning, using what he has gained from his first experience as a standard. His notion of particular lamps and his idea of lamps in general both start in this limited experience and develop gradually as his experience is extended. The young child calls all men "papa," or his first sheep "dog," showing that he has crude embryonic concepts from the first. But, referring to the latter illustration, further sheep experience may do two things to his concept: (1) It causes him to notice for the first time that his own dog has short hair, claws, and a long tail, thereby increasing the intension of the concept; (2) it restricts the extension of his general concept, since afterward he may not include sheep in it. Further modification of his concept takes place as he meets other dogs of different kinds. His experiences with bird-dogs, hunting-dogs, watch-dogs, etc., all modify his general concept, and at the same time bring out more definitely the characteristics of each individual. It is, therefore, in the process of forming general notions that the child gains a definite knowledge of particular things, and it is his contact with particular things that modifies and develops his general notion.

Now, while it is true that the foundation of knowledge must be laid in first-hand experiences with things themselves, it is also true that after we have gained a store of meanings in this way, we may extend our old concepts and gain new ones through creative imagination, when guided by language descriptions and definitions. I may, for instance, never have seen a zebra or a picture of one. Nevertheless, I may get a fairly accurate concept of this animal from my readings or from the descriptions given me by another person. Guided by oral or written descriptions, I may fill in the sensory details by concrete imagination, drawing, of course, upon my first-hand experience with similar objects (horses, ponies, mules) for the material of my ideal construction. These experiences are modified and reconstructed into my idea of the zebra. Many of our concepts are formed in this way. This form of conceptual growth and modification requires a higher stage of mental activity than that based upon perceptual experience.

Still a higher form of conceptual development and modification is found in our more abstract and scientific concepts, in the development of which neither perception nor concrete imagination plays any important, determining part. Such concepts consist of relations which we comprehend by means of the higher thought processes. Our concepts of infinity, law, force, atom, are illustrations. They are developed out of our knowledge of the relations existing between things, and which we discover through the processes of judgment and reason.

The concept, then, is the outgrowth of experience, in which perceptual and imaginary contact with things and the comprehension of relations in judgment and reason are prominent factors.

**Language.**—From the nature of the concept, we can see very plainly the need of a system of signs or symbols, to which we may attach our meanings. Every concept is a group of meanings which requires some tangible sensory content to call it up in our mind. We have already seen that the concrete image of an object serves in some instances to arouse its meanings. We have also noted the tendency in thinking to substitute for the concrete image of the object the image of the word which stands for the object. And, further, not only the image of the word, but also the actual perception of it may serve as a symbol of our meanings.

Language is a system of signs which we use to mark off meanings. Every word we use, or see, or hear, or image, is a symbol of something, and is, therefore, conceptual in nature. Thought deals with meanings, and language is the instrument of thought—the tool by which we handle meanings. If I should name in rapid succession a half-dozen things in my office: chair, pen, book, desk, door, table, you would in each instance understand what I mean—each word would arouse a definite set of meanings in your mind without the necessity of your forming an image of any one of the objects named. In other words, you have entertained a number of concepts. The mere presence of these unconnected concepts in your mind does not, however, constitute thinking. But if I should put some of these concepts together in such a way that my words express a relation between them, then thought would be aroused. Thus, I may pronounce the words: "The book is on the table near the door." Now, the words in themselves are nothing but a series of bare sensory sounds—mere symbols. There is nothing in the sounds that you hear which imitates or in any other way gives a clew to the condition which exists in my office. The words are merely arbitrary symbols of the meanings which arise in your mind. And as symbols, it makes no difference what they are, so long as we all agree to use the same symbol for any given meaning. I might have said just as well: "Le livre est sur la table près de la porte," or "Das Buch ist auf dem Tisch nahe der Thür." I might have written the sentence on the blackboard, or I might make use of the deaf and dumb alphabet, or if it were possible I might convey the thought to you through gestures and natural signs. The meaning in all cases would be the same. Some of the symbols, however, would be more convenient and expeditious than others. And in the last case, the nature of the symbols would differ in principle from all the preceding cases. In trying to make you understand by gestures and natural signs, I am necessarily obliged to use the primitive method of imitative or concrete imagery in arousing the meanings in your mind. I should have to point to this book, and that table, and that door in this room, and then by gestures try to make you understand the condition in my office. In all the other instances, the words suggest the proper meanings without the necessity of your filling in by concrete imagination as you do in this case.

From the psychological point of view, one of the functions of language signs is to arouse meanings, or rather to symbolize meanings in our own thought processes—to communicate ideas to ourselves, so to speak. For it is true that we think very largely in terms of words, *i. e.*, we use visual, or auditory, or motor images of words in thinking. As an instrument of thought, language signs sort out and preserve our meanings. Figuratively, we may say that a word is a pigeonhole into which we pack away certain definite meanings which we may use later by merely glancing at its number.

But language has other functions—the communication of meanings to others. Each word that I use arouses the meanings which you, through your past experiences, have attached to it. I may, therefore, direct your thought through language signs. As an instrument of communication, language is a social institution. The social aspect of it contributes very much to the development of conceptual thought. Each individual communicates to others the particular meanings which his experience has given him, so that in the end, any given language symbol comes to have a group of meanings, which is the product not of a single individual, but the result of the co-operation of the members of a social group. A word when used as a means of communication by several individuals becomes a clearing-house of meanings. The refinement, organization, and development of meanings which language fixes for us is due largely to social influences.

The earliest form of language (using the term in its broadest sense) is the language of natural signs, or imitative gesture. In natural signs, the symbol must have something in common with the thing symbolized, as when barking like a dog is used to communicate the idea "dog," or when one closes his eyes to signify sleep, or points to the clouds to indicate rain, or puts the hollow of his hand to the mouth to make known the fact that he is thirsty. It should be noted that gestures that merely point out objects are not really language signs. For instance, if I point to the clouds simply to call your attention to them and nothing more, then the pointing and the thing pointed out are not really signs. They do not signify anything beyond that which is present. A sign or symbol must stand for something beyond itself—something not present. It must imply some meaning in order to function as a language sign. If, however, my pointing to the clouds is for the purpose of signifying rain, then the act becomes a true symbol. Any gesture or imitative act which symbolizes something not present may be considered a language sign.[1]

But natural signs are cumbersome, inconvenient, and unmanageable, since they must consist in the reproduction of much of the original, sensory content of experience. Only by imitating the sensory appearance of things are natural signs able to convey an idea of them. This is at times impossible. At best only the simplest and crudest concepts and only those not too abstract can be represented by natural signs. "To make," says Taylor, "is too abstract an idea for the deaf-mute; to show that the tailor makes the coat, or that the carpenter makes the table, he would represent the tailor sewing the coat, and the carpenter sawing and planing the table. It is difficult or impossible to represent by natural signs what is common to all kinds of making in abstraction from what is specific in this or that kind of making. But if we use a conventional sign, such as the words '*to make*,' the difficulty disappears."[2]

The first primitive attempts to communicate ideas by means of written characters show the same tendency to imitate the sensory appearance of the things represented. Ideas were communicated by pictures (ideograms). Thus, a picture of a horse stood for the idea horse. But here, also, the picture is too cumbersome a form and has given way to the conventional written word. The picture was found hopelessly inadequate for representing concretely all the different aspects of an object and, failing in this, the ideogram became more and more merely a conventional sign or symbol.

It is a significant fact that we find even yet in our highly developed conceptual thought, controlled and guided by conventional language forms, the old primitive tendency of the natural sign-language to imitate in thinking the objects

[1] Stout: "Manual of Psychology," p. 471.

[2] Article on Language Function, Baldwin's "Dictionary of Philosophy and Psychology."

and events which form the basis of our thoughts. For instance, the copy images which so often arise in our minds are analogous to natural signs in this respect; only, of course, the former are used exclusively in our private thinking to represent ideas to ourselves. Like natural signs and ideograms, they, too, have given way to symbolic forms, in this case to verbal images.

A similar primitive attempt at concreteness manifests itself in the onomatopoetic tendency of language. Such words as *ding-dong, clang, jingle, mew, fizz, purr, pop, coo,* etc., are plainly attempts to get as much concrete sensory content as possible into the symbols of our thought. These imitative words have, however, become purely symbolic, for few of us ever image the sensory content which we symbolize when using the words. Hence, the word *ring* serves the purpose better than ding-dong to symbolize the ringing of a bell. In general, we may say that the more a word suggests concrete content, the less fitted it is to serve as a symbol of meanings. The sensory content aroused tends to draw attention away from the meaning of the term.

A study of natural language signs among primitive peoples, shows that signs tended to lose their imitative concreteness and to become more and more conventional, the more they were used. This result we should expect as a natural psychological tendency. For, as the power of thinking develops, attention is drawn away from the concrete character of the symbols of thought and directed more and more to the meanings which they convey. Also, the more a natural sign is used, the less need there would be for carrying it out completely in order to convey the idea. There is then a constant tendency to abbreviate natural signs.

**Origin of Language.**—Now, among the natural signs were some which have been considered the beginnings of our present conventional, spoken language. We refer to the imitative, vocal signs, such as "bow-wow," "mew," etc. But the imitation of the sound which an animal makes to signify the idea of it, like barking to convey the idea of dog, is in principle a form of imitative gesture. It is different only in that it involves the movements of tongue and other vocal organs instead of those of hand and arms.

It seems reasonable to suppose, then, that conventional language may be traced back to imitative gesture. Language in the broader sense must have found its origin in that stage of mental development where a natural sign of any kind was used to signify something beyond itself. Assuming the ability to reproduce imitative gestures and imitative vocal sounds, or the instinctive vocal expressions of emotion, all that is needed to make them serve the purpose of communication is the mental power of imaging the past experiences which have been connected with the gestures or sounds.

Just as soon as primitive man was able to represent consciously to himself the experiences which were associated with a certain movement or sound, it was a simple and natural thing for him to hit upon the device of reproducing the gesture or sound for the express purpose of suggesting the experiences to others. The fact that he could exert a certain control over others in this way must have given the language impulse a strong incentive at the very beginning.

The advantage which vocal sound has over visible gestures as a means of communication could not help but give it the lead. Vocal signs can be communicated in the dark. It is said that certain primitive peoples can communicate only imperfectly in the dark with each other, because visible gesture is such an important element in their language. They, therefore, are obliged at night to go to the fire to talk to each other. Vocal signs can also be exchanged between individuals who are unable to see each other because of intervening objects. Moreover, the vocal organs are able to function when arms and hands are otherwise occupied, or injured, or bound. A still more important factor rests in the fact that the vocal organs have no other function to interfere with the language function. These are some of the causes which have contributed, although perhaps not consciously, to the selection of vocal signs as the material of conventional language.

There are several current theories concerning the origin of vocal language, but they all disregard the connection which conventional language has with the primitive language of visible gesture. The "*interjectional theory*," nicknamed the "pooh-pooh theory," supposes that vocal language originated in the instinctive emotional expressions, such as the cry of fear, when used to communicate to others the idea of the presence of an enemy, or dangerous object. The "*onomatopoetic theory*," or "bow-wow theory," places the origin of language in the imitation of some characteristic sound which objects make to indicate the idea of the object, as when one imitates the barking of a dog in order to convey the idea of the dog. The "*pathognomic theory*," sometimes spoken of as the "ding-dong" theory, supposes that certain objects or events forced out, or "*rung out*," of primitive man certain vocal sounds which were in some way expressive of, or harmonious with and appropriate to the nature of the object or event; and that such sounds, being repeatedly "rung out" of the organism by these objects or events, finally were used to signify them, and so formed the nucleus of vocal language signs. Such a word as "zigzag" is an illustration. There seems to be a peculiar appropriateness of the vocal expression "zigzag" to the course of a zigzag line. The change in direction of the line is sympathetically expressed by the syllables "zig" and "zag." The English verb *suck*, German *saugen*, French *sucer*, also show a kind of harmony between the act of sucking and its name. The verb bubble is intrinsically expressive of the action of bubbles. In fact, there are in all languages so many cases of the close affinity between the names and the objects or events which they stand for, that there appears to be some ground for the "*ding-dong*" theory.

But in all these theories of the origin of vocal language, there is at bottom the principle of imitative gesture, which is neglected. This is evident in the interjectional and onomatopoetic theories. To imitate the cry of fear or the characteristic sound of an object is really a vocal gesture which describes some feature of a situation or object. Even in the pathognomic theory, appropriateness between the vocal expressions and the things they signify consists, as Stout has so clearly pointed out,[1] in the imitation by the movements of articulation of some feature of an object or event. The principle of imitative gesture is not so evident here, but it is nevertheless present. In zigzag, for instance, the tongue moves in imitation of the course of a zigzag line. To pronounce "*suck*," one must partially imitate the real act of sucking. It is even more evident in such a word as "pucker." In giving expression to the word "bubble," the lip movements really imitate the action of bubbling substances.

The "ding-dong" theory, therefore, proves more than it intends to prove. The theory is valuable just because it points out the fact that, in the beginning, speech was not only sound but *movement*, and that even here the movement took the form of imitative gesture—gestures made by the speech organs. This is quite as true of the "bow-wow" theory. For instance, barking to imitate a dog consists not only in imitating the sound of the dog, but it imitates the movements of the dog—it describes by imitative gesture the visible appearance of a dog barking. By consciously imitating the movements of a barking dog with the head and mouth, one will discover that the sound "bow-wow" is really caused by the gesture. The imitative movements will force a vocal expression which is a kind of rudimentary bark, like the dog's bark. The sound is really incidental to the gesture. All these facts lead us back to the statement made in the beginning of the discussion that the origin of language may be traced back to imitative gesture.

[1] "Manual of Psychology," pp. 484–486.

The origin of language appears to exemplify the growth and development of the concept. All attempts to use meanings in our thinking begin by imaging or reproducing some sensory quality of the thing thought of, and making that the symbol for the thing. This is essentially the principle of imitative gesture. Gradually, however, the tendency to imitate gives way and the symbols of thinking become purely arbitrary and conventional.

**Thought and Language.**—There is a tendency in some quarters to hold to the dictum: "No language, no thought." If by language is meant only the verbal forms of conventional language, then thought may take place without language. We have already seen that we may think in terms of concrete images. We may think of the relations between things by using the things themselves, or the images of the things, as symbols of thought. We may also think in terms of natural signs or gestures. It is true, however, that thought requires symbols, and words are the most serviceable symbols. It is also true that the development of language and the development of thought take place together, and that without the verbal signs of oral and written language our systems of thought could never have reached their present stage of perfection. There is no reason to suppose, however, that in the absence of the invention of words thought would have been impossible.

# CHAPTER XIV

## JUDGMENT

**Judgment and Perception.**—We have already pointed out the fact that every act of perception involves a rudimentary form of judgment. Perception contains the recognition of whatever is presented to the senses as similar to, or identical with, objects we have known before. In this act of recognition there is an implicitly experienced relation of identity between the sensory presentation and past contents of consciousness. If our view of perception is correct, we may suppose that in the baby's early stages of development each perception of its nurse involves a vague and undifferentiated experience: "This-thing-that-I-now-see-is-the-same-thing-that-has-bathed-and-clothed-me-before." In perception the relation of the present sensory content to past experiences is not explicitly experienced. This content is merged so completely into the unity of perception that the rudimentary judgment involved does not come to the surface of consciousness. In judgment, on the other hand, the relation between our mental contents of consciousness is explicitly experienced and attended to. We may, therefore, define judgment tentatively as the consciousness of relation between our mental contents. In so far as perception involves the relation of one mental content to another, it is the beginning of judgment. In taking up the discussion of judgment we are, therefore, not introducing a totally new process.

**The Nature of Judgment.**—Popular thought about judgment is based almost entirely upon the logical treatment of judgment. The logician is interested primarily in the language expression of thought. He therefore defines judgment as *the expressed relation between two concepts.* In formal logic, a judgment is a proposition containing a subject and a predicate, with a copula to conjoin them. Two terms verbally joined to show a relation between the terms—that is the judgment of logic. For the logician the printed or spoken sentence, "Iron is a metal" is a judgment, and is thought of and treated independently of the real conscious experience which is back of it. In psychology, on the other hand, we are concerned with the conscious states themselves—the actual mental processes that take place when we form judgments. Psychologically, judgments may or may not be expressed in language terms. And, moreover, the language form of a judgment may not adequately represent the mental process itself. We must therefore observe the actual conscious states in order to get at the nature of judgments.

**Judgment as Apperception.**—Psychologists are not all agreed in their definitions of judgment. It has been suggested by Kant that judgment is simply the entrance into consciousness of any presented mental content. He assumes that no presented content can become clear in consciousness until it has been received by, and assimilated to, an organized body of knowledge already in the mind. He says:[1] "I find that a judgment is nothing but the mode of bringing a given cognition into the objective unity of apperception." The "objective unity of apperception" here means the organized body of past experiences in the light of which any given presentation is understood or interpreted. For instance, on seeing a rose I have an experience which when expressed becomes: "That is a rose." In order to be clearly conscious of the rose, the presentation, or sensations which I get from the presented object must be referred to that which I have previously learned about roses. The combining of this previously organized knowledge with the presentation is, according to Kant, the judgment. The judgment is, therefore, in this case the conscious reaction to a group of sensory presen-

[1] "Critique of Pure Reason," Supplement 14, Sec. 19, Max Müller's translation.

tations, by virtue of which the presentations, or entering cognitions, are properly placed and incorporated into the knowledge I already have. This view of judgment is in accord with that in the preceding discussion of judgment and perception. It was there pointed out that the process of apperception is fundamentally a rudimentary judgment. If we follow out Kant's view critically, the judgment "That rose is red" contains two judgments. The language expression of the double psychological process would be: "It (the presented thing) is a rose," and "The rose is red." The presentation is apperceived (judged, according to Kant) both as a rose and as red. This example furnishes an illustration of the difference between the language form of judgment (logic) and the mental process (psychology) back of it. The judgment "That rose is red" is for logic a single judgment because the logician neglects the actual conscious processes involved in bringing each term of the logical judgment to consciousness. Each single term of the logical judgment is the result of an implicit judgment which does not show itself in language expression.

**Judgment as Belief.**—Another view makes judgment the conscious act of acceptance which we give to a sensory presentation or, indeed, to any other mental content. According to this view, judgment is a positive attitude of *assent* or *belief*. Conscious content that does not gain this assent fails, therefore, to develop into judgment. Judgment is something more than the entrance of a given content into consciousness. It is an attitude which we take toward the content. The attitude of belief is, accordingly, the true form of psychological predication. In this connection we should note that the so-called negative judgments, or judgments of disbelief, are negative only in the form of the language expression. The judging attitude itself is always a positive one. For instance, on seeing a counterfeit bill, I may exclaim: "It is not good." The judgment here consists in my acceptance of the presented content "not good." This acceptance is psychologically a positive attitude, although the expressed form is negative. The judgment involved in the sentence "The table is not round" is my positive acceptance of "not-roundness" as an attribute of the table. Psychologically there are no negative judgments any more than there are negative perceptions, or images, or memories. It is only from the logical point of view that judgments may be called negative, and then only because of their external form.

What distinguishes judgment from mere associations of mental contents? Some recent investigators of the processes of judgment contend that the distinctive judging process is the acceptance or rejection of conscious content presented to the mind as a solution to some problem. The problem may be consciously formulated, as when we look at a fabric in order to determine its color. Cognitive curiosity, or interest in the existence or non-existence of things may be sufficient to supply the problem. Accordingly, acts of judgment will arise whenever problems (implicitly or explicitly formulated) are set in consciousness, and whenever the contents supplied by association are received as satisfying or not satisfying the requirements of some intention of consciousness. The intention or problem may involve the question of whether a certain state of affairs is or is not true. This view of judgment is similar to the view which looks upon judgment as belief. They both presuppose that conscious content may be poised or held in consciousness without acceptance or rejection. Accordingly, consciousness is supposed to have a twofold character—that of conscious act and that of conscious content. Judgment, then, is the act of acceptance or rejection of conscious content.

**Judgment as the Ascription of Meaning.**—Still another view of judgment considers it to be the mental act of ascribing meaning to whatever presents itself to consciousness for interpretation or comprehension. This view has much in common with the view that judgment is a form of apperception. For it is plain that whatever meaning is ascribed to a thing depends upon the nature of our past experiences —upon the character of the organized systems of knowledge which have been previously developed in the mind. In other words, we judge (ascribe meaning to) a new situation in the light of past experience. When a given stimulus presents itself, the mental act of giving it meaning is an act of apperception. In a large number of cases, the presented object (the given) and its meaning are so closely and immediately united that the act of relating them is really a perception—a direct apprehension. The synthesis of the given and its meaning is so immediate that the distinction between them is not evident. But in other cases the meaning does not follow as closely upon the heels of the given. Just what the presented object is, or what its functions and attributes are —in other words, what its meaning is—is not immediately grasped. It is then necessary to search for and find a meaning which can be ascribed to the given. This mental act is much more plainly a judgment. However, the difference in the two classes of cases may turn out to be only a difference in the immediacy of the synthesis of the given and its meaning. If, for instance, a familiar object with a seat, four legs and a back is presented to my senses, I immediately apprehend (perceive) it as a chair. But if, on the other hand, an unfamiliar object, with three legs supporting a tilted board upon which is mounted a large wooden wheel, is shown to me, I am for the moment unable to place it in my mind. I should then be obliged to search for a meaning to give it before I could understand the thing. If I were acquainted with early colonial customs, I should then recognize it as a spinning-wheel. In the one case, the meaning comes without delay and is not sundered from the given. In the other case, the meaning is delayed and is consciously united with the given. In one, the meaning is implicitly, and, in the other, explicitly, ascribed. However, according to the view we are discussing, both cases are fundamentally the same, and are, psychologically, judgments. Even granting the soundness of this view, it would be more convenient and less confusing to apply the term judgment only to those cases where meaning is explicitly ascribed to whatever is presented to consciousness, thus allowing the term perception to include all cases of direct apprehension. Such a distinction would be in accord with the point of view taken in the beginning of this chapter.

**Judgment as Comparison.**—A view of judgment which is older than any so far mentioned is the one that considers judgment as involving the process of comparison. We judge when we compare. Or, to turn the statement about, in order to judge we must compare two presentations, ideas, or concepts, and mentally assert some relation between them. Thus we form judgments when we compare two weights and decide whether they are alike or different in weight. It is, of course, true that we may make judgments in this way, but judgments are certainly not limited to acts of comparison. Judgments which assert existence, as "There are twelve months," and impersonal judgments, as "It rains," do not involve comparison. Even where judgment by comparison is possible, careful observation has shown that it may take place without comparison.[1] For instance, in the experiment of judging the likeness or unlikeness of two weights, it would seem that when the subject lifts the second weight he must recall the impression made by the first weight and compare it with that of the second weight in order to judge whether the second weight is the same or different. But investigators have reported that no recollection of the first weight need be present when the judgment is made. The second weight is therefore not consciously compared with the first weight. The judgment of "same" or "different" is made immediately upon the impression produced by the second weight without any conscious recall of the first weight. The first weight leaves a conscious "set" or adjustment which prepares for the judgment and when the

[1] Schumann, "Zeitschrift für Psychologie," 1898, XVII, 119.

second weight is lifted the judgment of "same" or "different" is made without any conscious reference to the first weight. The judgment in such cases depends of course upon the nature of past experience (the experience of the first weight), but it is not the result of conscious comparison of the first weight with the second weight. The judgment comes as immediately and directly as the recognition of a familiar object. Every-day experience furnishes many illustrations of judgments which might follow the process of conscious comparison but which actually take place without it. On meeting a man over six feet in height we immediately form the judgment—"very tall"—"taller than usual," without consciously recalling and representing to ourself the heights of other men and comparing the presented individual with those we recall. We are already prepared by our past experience to form the judgment directly, without conscious recall and without comparison. Thus in the illustrations we see that the judging process may approach that of immediate apprehension or perception, which is essentially the entrance of the given into a predeveloped system of knowledge.

**Judgment as Evaluation.**—A popular way of considering judgment looks upon it as a process of evaluation. When a given presentation is evaluated according to some standard, the mental process is that of judging. Thus the stockman judges the weight of a fat steer. The standard by which he judges is that which he has formed in his former experience with cattle. The judge on the bench after hearing a case renders judgment, *i. e.*, gives a sentence, corresponding to the offense or fixes the damages in accordance with the losses sustained. In both instances a given presentation or situation is evaluated by referring it to a standard. The standard of judgment may be in certain cases consciously represented, and the given presentation compared with it. The judgment is then formed as a result of the comparison. Or, on the other hand, the standard may not be consciously represented when the judgment is made. We have here the same mental process that we find in judgments of absolute pitch. Those few musicians who possess the power of absolute pitch have formed such close associations between the different musical tones and their names that when they hear a tone, its name immediately arises in consciousness. Likewise the stockman in his extended experience with cattle has formed close associations between their visual appearances and the scale of weights. When a certain size and form is presented, his judgment of weight takes place immediately without reference to a clearly defined standard. In such cases judgment is merely a sequence of mental states which may be likened to the association of ideas.

Because of perfect familiarity gained through extended experience in a certain field of knowledge a given presentation may call up immediately its evaluation without the mediation of the standard of judgment which was earlier an essential element in the process. The expert bank teller judges a bill to be good or bad immediately without consciously representing to himself his standard of judgment. On the other hand, many judgments of evaluation are made only after the given presentation is referred to and compared with a mental standard which is consciously represented at the time of judgment.

There is a tendency in certain quarters to base judgments of evaluation on the feeling processes. It has been said with some degree of truth that the judgments of value which we pass upon the facts and events of life depend not so much upon the rational ordering of mental contents, as upon the personal choices determined by our feelings. Consequently, to approach, or appreciate reality we must "feel" it, or in a way "live" it. The judgments which we form concerning the value of works of art (æsthetic judgments) are used as illustrative of all judgments (evaluation). We evaluate a painting or an opera only when it appeals to our feelings. There is, therefore, an emotional standard for such judgments. According to this point of view, the basis for our estimation and appreciation of values lies deeper than our formulated knowledges. There is no doubt of the fact that the feelings do modify the cognitive processes to a marked degree, but we cannot admit that the feelings form an independent and distinct ground of judgment. Where the cognitive standards for evaluation are not plainly evident it is very probable that the standards of evaluation are to be found among former cognitive experiences which have been thoroughly assimilated and submerged into our personality.

In whatever way we may consider judgment—whether (1) as the entrance of a given presentation into consciousness, or (2) as belief, or (3) as the ascription of meaning to the given, or (4) as comparison, or (5) as evaluation of the given, the essential mental process in judgment is the *arousal* and *reaction* of conscious content already in the mind upon newly entering content. The judging process is best typified by the view that judgment is the ascription of meaning to the given. The entrance into consciousness of any given presentation is identical with that of ascription of meaning. The reaction of consciousness takes place only when the given presentation enters consciousness and is at the same time interpreted in the light of some mental standard which has grown up through past experiences. Belief also may be considered as intimately connected with the entrance of the given into consciousness if not part and parcel of the same process. Belief is a mode of conscious reaction, determined by standards of past experience. I cannot see how any given presentation can enter consciousness without involving some degree of belief or disbelief.

We have already seen that comparison may be and usually is an immediate conscious reaction upon the second term of the comparison without the formal representation in consciousness of the first term. The judgments "longer," "shorter," "brighter," "smaller," etc., may be direct and immediate conscious reactions made at the instant the second of two objects is presented. This has been demonstrated in the experiment of lifted weights. Evaluation, too, results from the direct and immediate reaction of standards of experience awakened by entering contents of consciousness. Sometimes this reaction of consciousness is merely that of simple apprehension in which the content already in the mind is not formulated and attended to. In such cases we have implicit judgments. In judgments proper, however, the standards by which we interpret the entering content are consciously formulated and attended to. In this case there is a dual act of attention. Attention is divided between the mental contents. This division of the attention brings out the relation between the contents and unifies them into a single whole.

In its most developed form, then, judgment is the process of consciously relating one mental content to another. Judgment is therefore the experienced relation between two mental contents. The relation may be of any kind whatever: relations of dependence, substance and attribute, cause and effect, whole and part, sameness and difference, temporal, spatial, etc. The simplest and most primitive judgments are one-term judgments such as the interjectional judgment, "Wolf!" the impersonal judgments, "It rains," and the demonstrative judgments, "There is a tree." In these cases the mental content by which we interpret the given is not consciously formulated, and for this reason it is difficult to differentiate the judgments from simple perception. Logicians have always had trouble with these judgments for the reason that in logic judgments are supposed to be made up of two terms—a subject and a predicate. What then are the terms in such judgments as "It snows," "Fire," "There is a tree"? Psychologically there is no difficulty when we understand that the second term that the logician is looking for is the mental standard by which we interpret, or ascribe meaning to the given presentation.

In our discussion of judgment as the entrance of a given presentation into consciousness, ascription of meaning, belief, comparison, and evaluation, we have so far spoken almost entirely of one-term judgments, or judgments involving a single presentation and its interpretation. Now, many of the judgments of the logician, having two terms when expressed in language form, are psychologically one-term judgments. The interjectional, the impersonal, and many of the demonstrative, and assertative judgments consist in the single act of giving meaning to a given presentation. There are, however, many two-term judgments in the psychological sense. Thus in the judgment, "The rose is red," there are two presented contents which are united in the judgment. In such judgments, in addition to the act of joining the two terms through some explicit relation, there are, psychologically, two interpretations, or judgments, involved which are not usually considered in logic. They consist of the entrance into consciousness of the two presented contents. On the other hand, it is the relational joining of the two presented contents which constitutes the judging process of formal logic.

**Kinds of Judgments.**—There are many ways of grouping judgments. Sometimes the character of the mental contents related in the judgment, and sometimes the character of the relationship itself between the contents determines the classification. Even the form of the language which expresses the judgment is sometimes used as a basis of classification.

Grammarians and logicians speak of *assertative judgments*, *hypothetical judgments*, and *disjunctive judgments*. The assertative judgment is a simple assertion, as, "The grass is green." The hypothetical judgment is an assertion subject to a given limitation, as, "If it rains, he will get wet." The disjunctive judgment is an indeterminate assertion, naming two or more possibilities which may exist in relation to a given subject in such a way that the truth of one excludes the truth of all the others, as, "He is either a Democrat or a Republican."

Judgments may be classed as *individual judgments*, *general judgments*, and *abstract judgments* accordingly as they deal with a single thing, a group of things, or an abstract quality.

*Perception judgments* are judgments made about things presented to the senses. They may take the form of *interjectional judgments*, as when the shepherd boy cries out: "Wolf!" Or they may be *impersonal judgments*, as, "It rains." In the impersonal judgment the field of perception is taken in an indefinite manner as the object of thought. On the other hand, when attention is narrowed to one particular point in the field of perception the judgment is a *demonstrative judgment*, as, "That is a tree." Genetically the interjectional and the impersonal judgments are primitive forms of judgment. Perception judgments may also be looked upon as *judgments of naming*, or, *judgments of classification*, as, "That is an animal." If we should carry out the classification suggested we have not only judgments about things perceived, but judgments about things remembered, things imagined, and things generalized into concepts.

Among *judgments of comparison*, or *judgments of likeness and difference* there are *mediate judgments* and *immediate judgments*. We have pointed out that in comparing two lifted weights the experience of lifting the first weight may be kept explicitly in mind while the second weight is being lifted, and compared with it. In this case the resulting judgment is a mediate judgment. On the other hand, when the judgment of lighter or heavier is made directly without explicitly recalling the impression of the first weight, the judgment is an immediate judgment.

Judgments may be classified according to the kinds of relationships which subsist between conscious contents. This principle if carried out consistently would give a long list of judgments. But since the relationships of cause and effect, of substance and attribute, and of space and time occupy a large part of all thinking, the classification of judgment upon this basis is limited to judgments of *cause and* *effect,* judgments of *substance and attribute,* and judgments of *time and space.* Whenever we think of one thing or process as existing or taking place as a consequence of another thing or process we employ the judgment of cause and effect; as, "Poverty brings misery." Whenever we think of a thing and its essential quality or characteristic we employ the judgment of substance and attribute; as, "The ring is round." Judgments of time and space are expressed by such words as earlier, later, before, after; and right, left, above, below, etc.

**Analysis and Synthesis.**—Judgment may be considered both as analysis and synthesis. We employ judgments in dissecting relatively total experiences into the different constituents of which they are composed. Thus in the judgments, "The grass is green" and "Circles are round," we are analyzing out of the percept in one case, and out of the concept in the other, elements which are already present in our consciousness of them. They are therefore *analytic judgments.* On the other hand, we employ judgments in putting together contents of consciousness which have never been together before or which are not obviously conjoined in our consciousness until the judgment takes place, *i. e.*, we add something to a given conscious state. Thus in the judgments, "Grass is valuable" and "Circles are symbols of eternity," we are adding something to our concepts of grass and circles which was not previously present, and, evidently not contained in them. They are therefore *synthetic* judgments. If, however, the ideas of "value" and "eternity" were already parts of the concepts at the moment the judgments were made, the judgments must be considered as analytic. Whether a judgment is analytic or synthetic depends upon what is in consciousness previous to the judgment. If in the judgment, "Lead is heavy," we suppose that the concept of lead already included the idea of heaviness as a constituent part of it, then the judgment is analytic. On the other hand, if we suppose that our consciousness of lead did not at the time include the idea of heaviness but that the two contents were separate elements of thought, and were united by the judgment, then the judgment is synthetic. Without doubt we do put together separate mental contents in a synthetic way and note relationships of which we were not previously aware. On the other hand, relationships of which we are only vaguely cognizant in a single total experience, perceptual or ideational, may be brought to the focus of consciousness and made clear in the analytic judgment.

In judgments of perception where the two contents of the judgment are explicitly presented to the senses the process is obviously analytic, as, "The paper is white." But if one of the contents is supplied out of past experience, *i. e.*, remembered, the judgment is synthetic, as, "The paper belongs to John." In this case we are adding to the perception a content not explicitly present in it.

Sometimes what we add to a given percept or concept may come not from specifically remembered past experience, but from generalized knowledge, or general truth. It is just here that synthetic judgment passes into inference. If, for instance, I conclude that a certain piece of lead which I see is heavy, not because I remember that it is heavy, but because I know that "All lead is heavy," then the judgment is an inference—the result of a reasoning process depending upon the presence in the mind of a general truth.

Judgment, therefore, may be traced from apperception to reason through gradual changes in the explicitness of the relationship involved. In the perception or apprehension of any external object past experiences are *implicitly* added, or related to the given presentation. The object is apperceived, or received into the organized body of knowledge. This process is a primitive form of judgment—an implicit judgment. In the synthetic judgment the added content is explicitly and consciously joined to the present content of consciousness through memory. In inference the added content comes through generalized knowledge.[1]

[1] For a fuller statement see Pillsbury: "The Psychology of Reasoning," pp. 172–175.

From the genetic point of view judgment is an analytic-synthetic process. It is by means of judgments that we first break up our vague total experiences into definite and distinguishable parts and organize them into systems of related knowledges. The baby's world is at first a vague, confused mass of experience. Judgment begins in the analysis of this total experience into its constituent elements, but at the same time these elements of knowledge are synthesized through judgments into organized systems of knowledge.

**Judgment and Concept.**—If we examine the beginning of concepts we shall find that they originate in rudimentary judgments, or vague recognitions of relations between the parts of experience. As the child analyzes his hazy experiences into their elements, and sees the relations between them more clearly, his ideas about things become more definite. Things assume meaning for him. The mental activity by which he clears up and marks off his world of things into definite groups of meaning is essentially the process of judgment. Thus "mother" comes to mean "to feed," "to rock," "to bathe," in short, all forms of maternal care; "ball" means "to roll." These meanings, however, are based upon particular recognition of relation between different contents of his experiences. The later development of his concepts is brought about through explicitly formed judgments. Each new characteristic which we discover about an object gives a new meaning which is straightway embodied in the concept. The concept grows, therefore, both by the addition of new relationships given through judgments and by the clearing up of old relationships which are already vaguely present in our experience. Judgment is, therefore, the conscious process by which we arrange our experiences into systems of knowledge (concepts). The concept then becomes a series of potential judgments, any one of which is available for use whenever needed and called for by the context of consciousness or purposes of thought.

Not only, then, is judgment the means of forming concepts, it is also the means of making use of concepts in thinking. From the psychological point of view all the judgments making up a concept cannot be thought of as actually existent at any one moment. It is, therefore, only for convenience sake that we sometimes speak of a concept as a sum of judgments. What is really meant is better expressed by speaking of the concept as a centre of meaning from which radiate a series of possible judgments, only one of which can become explicit and definite at any one instant of conscious activity. Judgment is the means by which we analyze and unfold the developed concept and transform its meaning into definite forms for use in thinking.

**Judgment as the Fundamental Cognitive Activity.**—Consciousness of relation is a fundamental cognitive experience. Without it, consciousness would reduce to a series of separate mental flashes, and would be without any kind of continuity. To be sure, some schools of thought have denied that the consciousness of relation exists. Hume, for instance, said: "The stream of thought is not a continuous current, but a series of distinct ideas, more or less rapid in their succession." The old intellectualists also denied that consciousness of relation can be a content of consciousness. They held that no such experience can be found as a content in consciousness. Instead of consciousness of relationship, they substituted an "act of pure thought," above and entirely different from conscious content, which unites the separate sensations and ideas, and gives continuity to consciousness. James, on the other hand, is an able defender of consciousness of relation as a content of consciousness. He likened the stream of consciousness to the movements of a bird in the tree tops—an alternation of flights and perchings. The resting-places correspond to the substantive contents of consciousness, (sensory experiences and ideas) and the flights to the transitive contents (consciousness of relation). We have, he said, a consciousness of "and" and "if" and "by" and "but" quite as truly as a consciousness of "blue" or "cold."

There is in my mind no doubt of the fact that sensory impressions and ideas appear in consciousness in a relational aspect, and that the consciousness of relation is a necessary and fundamental constituent of conscious activity. From the very first, sensory impressions appear similar to or different from preceding impressions. The consciousness of difference may be vague and indefinite, but if it were not present there would be no differentiation of sensory experiences. Rudimentary and nascent experiences of recognition depend upon the relational experiences of sameness, or similarity. We have seen that perception of a simple object involves some degree of recognition of the sensory experiences as the same as, or similar to previous experiences. We could not apprehend the simplest object without this consciousness of relationship. The experienced connection of sensory stimulation with something already familiar is a primitive and implicit form of judgment. Perception and judgment are therefore different stages in the same fundamental conscious activity. We have also seen that the concepts are both formed and made use of in thinking through the instrumentality of judgments, and we shall see later that reason is nothing more than the manipulation of judgments in a relational way. From the simplest direct apprehensions to the most complex cognitive activities some form of judgment is always present and fundamental.

## CHAPTER XV

## REASONING

**Inference.**—It was stated in one of the previous chapters that the three aspects of reasoning are conception, judgment, and inference. These are not separate processes, but interdependent mental activities which we have separated only for the purpose of discussion. Judgment, as we have seen, is involved in the concept, and we shall soon see that inference and judgment are but different stages of the same process. Indeed it is difficult at times to distinguish between judgment and inference. Moreover, just as the line between judgment and perception is psychologically not a hard and fast one, it is also not an easy matter to determine just how much of inference is contained in perception. Helmholtz, for instance, looked upon perception as unconscious inference.

Inference is the process of consciously adding to a given presentation or direct cognition something not obviously contained in it. If I say that the paper before me is white, it is evident that the whiteness is present in the presentation, and that I am not transcending what is given in direct cognition in making the judgment. But if I say that the paper will burn, I am supplying something not contained in the present presentation. This something is supplied out of my past experience and I am therefore transcending my direct and immediate consciousness of the object. I may infer that the crystal in my watch will break if it drops upon the floor; that the lead paper-weight upon the table is heavy; that all men are mortal, etc., etc. In each of these cases I am making a judgment, and at the same time there is present in my mind, more or less explicitly, a reason or ground, for the thought entertained. We may say very crudely that inference is judging with a reason, or conscious ground, for each judgment. In inference, the conscious content added to the given presentation is accepted because of some felt reason, or ground for it. For instance, I add to the presentation of that paper-weight the thought of heaviness, because I am at the moment conscious that all lead is heavy. If I had in mind no reason, no conscious support for thinking the paper-weight heavy, the experience could not be called an inference proper, but simply a judgment.

**Inference and Perception.**—We said that inference is the process of adding to a given presentation or direct cognition something not obviously contained in it. Now, every act of perception goes beyond the sensory presentation and adds content not present to the senses. For instance, when I perceive the paper-weight on the table, my experience of the object depends upon more than that given in direct cognition. How, for instance, can I say the object is lead without drawing upon the knowledge already in my mind and supplementing the given sensory experience by something not obviously present? Here we have the "unconscious inference" of Helmholtz. When we examine our perceptions carefully, we are struck with the poverty of the given sensory experiences and with the wealth of conscious content read into them through the process of apperception. Very little is given by external stimuli, much comes out of the contents of past experience. If the word ψυχή were shown or spoken to a person ignorant of the Greek language he would experience the sensory visual form of the word, or hear the sound, but form or sound would mean nothing to him. But if he were familiar with the Greek language he would understand the word directly. It would then have meaning for him. In the case of the lead paper-weight just referred to, the sensory presentation (color, etc.) means "lead" for me, and I perceive it as lead. In a similar way all the familiar objects about me—books, tables, chairs, etc.—

have meanings by virtue of which I apprehend them directly. But suppose an object with which I am not familiar—several small shell-like beads strung together—comes to my notice. I am at first unable to apprehend it. I stop and search for its meaning and then it dawns upon me that it is a piece of Indian money, or wampum. In this case my understanding of the object is indirect, mediated by my knowledge of early Colonial times. The mental process by which I find its meaning is very much like inference, or reflective thought. There are, then, two ways of grasping the meaning of a given presentation—direct and indirect understanding. In direct understanding the object and its meaning are so closely united that they appear as one. In indirect understanding the object and its meaning are sundered until they are brought together by thought. In one case we *apprehend* (perception) and in the other we *comprehend* (inference) a given presentation. The difference between perception and inference lies only in the manner in which the given presentation is supplemented or interpreted. If the interpretation is immediate, we have perception, but if the interpretation is delayed and involves reflection we have inference.

**Inference and Judgment.**—Inference always ends in judgment, but all judgments are not inferences. How shall we determine when a judgment rests upon inference and when it does not? If a given object is understood at a glance, as in the judgment, "This is paper," we have a simple perception, judgment, or mere apprehension. If we say, "This paper is white," we have an analytic judgment. In this latter case both subject and predicate are given and analyzed out of a total sensory presentation. But if we say, "This paper will burn," it is not easy to determine whether we are dealing with a synthetic judgment, or with inference. If the quality of combustibility is supplied by a specific memory act, or if through familiarity with paper and its attributes the thought of combustibility follows the consciousness of the paper immediately or habitually as an association, the mental process is a synthetic judgment. But if the quality of combustibility is added because of the larger thought, "All paper will burn," then the judgment rests upon an inference. Since the conscious ground for inference may be present in all degrees of explicitness—from the case where it is only implicitly present to those cases where it is consciously formulated and expressed—it is evident that synthetic judgment shades off gradually into inference.

**Inference and Concept.**—In the judgment, "That paper will burn," the inference consists in regarding the presented object, "that paper," in the light of a larger body of knowledge about it. Now, since the concept "paper" is a group, or system of meanings which points out or signifies this larger body of knowledge, it becomes evident that inference is the act of making explicit the meanings stored away in the concept. Inference, then, may be looked upon as the process of analyzing the concept, selecting the proper meanings and making them explicit in judgment—an unfolding of the concept in the interest of some problem present in the mind. For instance, in this particular case I might be searching for material to kindle a camp-fire. When, therefore, a part of this particular system of knowledge is presented to consciousness, the part not presented but needed in the solution of the problem is called into action. Inference, then, makes actual and explicit what is potential and implicit in the concept. If it were not for the fact that knowledge organizes itself into systems in which one part sustains relations to other parts, and in which the system as a whole subsumes all its parts, inference would be impossible. Psychologically, of course, the whole system is never presented at any one moment, but its parts are potential in the concept in the form of meanings. Inference may be regarded as a penetrating insight into or a searching analysis of our concepts for the purpose of revealing the solution of a problem before the mind.

While inference involves analysis, it also involves synthesis. It is quite as truly the act of adding new meanings to our concepts. For instance, my individual notion "that paper" may not contain the meaning "combustibility." It may not occur to me that that piece of paper will burn until I have analyzed this characteristic out of my general knowledge and added it by means of the inference to my individual concept "that paper." Inference is therefore synthetic as well as analytic. We shall have more to say about this point when we consider the deductive and inductive methods of thought.

**The Nature of Reflective Thought, or Reasoning.**—A mere succession of mental states does not constitute thinking in the highest sense. Thinking is not merely a series of conscious states, but a sequence of conscious states in which each state determines the next as its consequence. We recognize this when we speak of the "thread of thought." Thinking is properly limited to the acceptance of ideas because they rest upon evidence or knowledge which transcends immediate presentation.

Reflective thought involves the awareness of the grounds for our conclusions at the time they are made. Much of our so-called thinking, however, does not involve the grounds for belief. Oftentimes we take things for granted, either because we accept the word of others, or because of tradition, or because we are influenced by our own personal advantage or emotional interests. In such cases there is no examination of the real grounds for our conclusions. Superstitions and prejudices arise in this way. Belief in protective tariff, or free trade, in the fatal outcome of thirteen at table, in our own possessions as the best in the neighborhood, and in our own actions as right, etc., etc., too often arises not because we consider these beliefs in the light of the evidence that supports them, but because of the factors just mentioned. Locke says that the lack of reflective thought can be traced to such sources as (1) the tendency to depend upon the thought of others and thereby avoiding the pains and troubles of thinking for ourselves, (2) the tendency to put passion in the place of reason, and (3) the lack of knowledge of facts due to circumscribed or limited experience. Now, while psychology is not concerned with the question whether a given thinking process is correct or incorrect, it is interested in determining what mental elements are found in both good and bad thinking. It may, therefore, point out the difference between the thinking process which utilizes the grounds or warrant for its conclusion and the thinking process which does not. It is this difference which distinguishes reflective thinking from mere association, or succession of ideas. The man who reads the barometer and predicts rain may, or may not, be thinking in a reflective way. If he understands the relation between a low barometric reading and low atmospheric pressure, and if he understands why low atmospheric pressure is favorable to storm formation, then his conclusion may rest upon and come out of this understanding. In this case, he is exercising reflective thought, or reason. But if the relation between low barometer and storm formation is no part of his thought—if he thinks or predicts rain simply because he merely associates low barometer with rain, then his thinking is of the unreflective type.

**The Steps in Thinking.**—Dewey, in his excellent little book, "How We Think,"[1] analyzes a complete act of thought into five distinct steps: (1) the problem, or felt difficulty; (2) the location and definition of the problem; (3) suggestions of possible solutions; (4) the development of the implications of the suggestions; (5) further observation and experiment leading to acceptance or rejection of the suggestions. This is a formal and logical outline of the phases of a more or less protracted series of thoughts centering about some problem. We may, however, profitably examine it for the light it throws upon the psychology of thinking. The first step refers to the fact that reflective thought originates in the presentation to consciousness of some perplexity or difficulty. If everything presented to us could be understood at a glance there

[1] Chapter 6.

would be no occasion for thought. The second step consists in comprehending the nature of the difficulty or problem. In most cases the presentation of the problem and its location and definition come to consciousness at the same time. Steps one and two are often not separable. The third step consists in the arousal of suggestions for the solution of the problem. This step is inference as we have discussed it. The suggestion is something not presented in the given situation, but supplied out of our general knowledge. The fourth step is finding out what implications follow the suggestion, and the fifth step is determining through observation or experiment whether the implications tally with the facts as found in further observation of the given situation. This last step is the verification of the suggested solution. Until this takes place the conclusion is hypothetical. If the implications are found to be true then we accept the suggested solution as the true one. We may use Professor Dewey's illustration of the steps of thinking in a particular case.[1] Suppose that a man on entering his rooms finds the contents of his drawers emptied upon the floor and everything in confusion. At first he is perplexed. Here is something to be explained. Steps (1) and (2)—the problem and its definition—appear together, because he understands the nature of the problem at once. The next step (3) is the arousal of suggestions. Burglary occurs to him as an explanation. Other suggestions might also come to mind—pranks of children—some friend may have been playing a joke. If burglars have been in his rooms then he will find his jewels and money gone and the locks forced. This is step (4) or the development of the implications of the suggestion. Step (5) is further observation to find out if the implications are true. Carrying out this step, he finds that one of the windows has been broken open and that all his money is gone. This closes the matter and he accepts the hypothesis as a reasonable one.

Now, it is plain that the central psychological process

[1] See Dewey, "How We Think," chap. 7.

among these various steps is the inference. It is found both in the arousal of suggested solutions of the problem, and in the development of the implications of the suggestion. When the man in the illustration passes in thought from the presented situation (disordered room) to something not presented (burglars) he is making use of inference. Likewise his mental process is inferential when he concludes that if burglars have entered his rooms he will find his money gone and the doors or windows forced. In the one case the movement of thought is from presented particular things to some general principle of explanation, while in the other, the movement is from the general principle back to particulars. The first movement of thought is *inductive* and the second is *deductive.*

**Kinds of Reasoning.**—Inference, then, may be of two kinds: *induction*, or *deduction.* It is deductive when we pass from a general principle to some particular case and believe in the particular because of the general principle. If we infer that a particular piece of lead is heavy because of the general law that all lead is heavy the inference is deductive. On the other hand, inference is inductive when we pass from particulars to a general principle, or law, and believe in the general law because of the particulars. If, after observing that every particular piece of lead that we have come in contact with is heavy, we infer that all lead is heavy, the inference is inductive.

It is commonly said (1) that in deduction thought goes from the general, or universal, to the particular, while in induction thought goes from the particular to the general; and (2) that induction precedes deduction. While these statements may be true from the point of view of logic we shall, in our psychological treatment, have reason to modify them somewhat. In actual thinking there is no such thing as purely inductive or deductive thought. Any specific case of thinking involves both the inductive and deductive processes. In some cases the emphasis of thought is on the deductive side while in other cases it is on the inductive. It is evident that deduction is the application of old knowledge or habits of thinking to new situations, while induction is the formation of principles, or habits of thinking. But induction cannot take place without the deductive use of old knowledge. In so far as it is necessary to identify each particular case in the induction which yields the general principle "All lead is heavy," the process is deductive. Without the application of old knowledge we could not know that the different presentations or individual cases belong to the class under observation. In order to be sure that the induction will be valid each new instance must be tested by old principles of knowledge. The inductive movement, therefore, is constantly under the guidance of the deductive process. Moreover, in practical thinking induction seeks the general principle through particular facts not merely for the purpose of finding the general principle but for the purpose of explaining or interpreting other particular facts. Induction, then, is not so much a movement of thought from the particular to the general as it is a movement from particular facts to particular facts through the general principle which is used not as an end in itself but as a basis or ground of explanation. Neither is it absolutely true that induction precedes deduction. They both take place at the same time. We do not first collect a lot of facts and then generalize them. But from the very first the facts are collected under deductive control, *i. e.*, each new fact becomes a basis of interpreting succeeding facts.

Deduction just as truly involves the inductive movement of thought. When we apply a general principle to an individual case and infer that a specific consequence will follow because of the general principle, the inferred fact then becomes a new instance for the support of the general principle. In so far as we think of it as new evidence for the validity of the general principle, we are generalizing in an inductive way. In practical thinking general principles are rarely so complete that they are not fortified or modified by the new specific instances or individuals brought under them. When an individual case modifies or changes a law the thought movement is inductive. Concerning the time-worn statement that in deduction the movement of thought is from the general to the particular, observation of real cases of thinking outside of logic books will show that here, too, the movement is from particular fact to particular fact. Practical thinking never starts with a general principle, but rather with individual and specific facts. In deduction it is always some particular individual presentation that calls for interpretation. If we infer that "that paper will burn," or that Socrates is mortal, the thinking is started by the particular piece of paper or the particular Socrates, and proceeds to the particular idea combustibility or mortality. In deduction it is the individual that is problematic and is given a particular interpretation by virtue of the general principle. In induction some particular instance makes the general principle problematic and either modifies it or supports it. In all cases practical thought begins and ends in particular facts.

There is another form of inference which is usually considered inductive in method although it is based upon a single case. I refer to *reasoning by analogy*. Inference here is based upon the similarity between individual cases. If, for instance, I infer that salt is sweet because of its similarity to sugar I am reasoning by analogy. The argument for mental telepathy based upon wireless telegraphy is a case of reasoning by analogy. There is a psychological tendency to think that if "a" manifests the characteristic "c," then "b" which resembles "a," will also have the characteristic "c." The degree of belief aroused will vary with the closeness of the similarity between the cases. Logic does not consider inference by analogy valid, and we must admit that it is the source of many errors in thinking. It is, however, very widely used in our every-day thinking.

Logicians have claimed that deductive reasoning can not make any advance in thinking or give any new truth, for the reason that the conclusion is already contained in the general principle. If, for instance, we know that "all lead is heavy," we certainly must know that any particular instance of lead is heavy, so that the deductive conclusion in such cases is not a new truth. We hold, however, that in many cases what is contained in a general principle may not have been applied by us to all specific cases which can be subsumed under it. When we make this application the deductive conclusion is a real gain and is, so far as we are concerned, a new truth.

On the other hand, inductive inference has been criticised on the ground that it cannot properly go beyond the particular facts which have actually been examined and therefore does not add anything to our knowledge. For this reason the validity of inductive generalizations has been questioned. By what warrant or right can we assert the general law that "all lead is heavy"? We are unable to examine all the cases, so that the method of enumeration can never be completed. Therefore, to pass from the cases examined to the general law is the so-called "inductive leap." The difficulty here comes from the attempt to consider induction as a method of thought separate and apart from deduction. The warrant for the so-called inductive leap is essentially a deductive one. Isolated facts are of no value, they cannot be used without some reference back to accumulated experience. No particular experience becomes effective except as it is incorporated into old habits or types of thinking. The power of induction to establish belief does not come from the particulars as particulars, but because they express previously established principles or represent typical conditions of the world as we know it. To be more explicit, if we find a certain characteristic like heaviness always present in a number of cases of lead, we are predisposed by past experience to expect that this characteristic will be found in all pieces of lead. We have grown to believe in the general principle that nature is uniform and law-abiding in her manifestations. We have faith in the general law that whatever happens under given conditions will always happen under the same conditions. So strongly is this principle intrenched in our minds that we are willing to make inductive generalizations upon the examination of a single case provided the case is a typical individual of its class. When this is true, one case is as good as a hundred. The warrant, then, for inductive inference is found in a general principle formulated in the mind by past experiences.

**Reasoning and the Syllogism.**—The logician looks upon inference as the process of uniting two judgments in such a way that a third judgment, containing a new truth, arises as a conclusion. This sèries of judgments is the syllogism:

> All lead is heavy;
> This paper-weight is lead,
> Therefore, this paper-weight is heavy.

These three judgments are called the major premise, the minor premise, and the conclusion. The major premise asserts a general principle. The minor premise applies the general principle to a particular case and the conclusion states the new truth. This is the syllogism of deductive logic. Inductive logic has no one special form of inference, although it has several different methods through which inductive inference works. To one who has observed what really happens when he is reasoning, it is evident that the syllogism does not represent the manner in which conclusions are reached. In most cases of actual thinking the only thing that is clearly formulated in consciousness is the conclusion. The minor premise is rarely if ever formulated when we are making inferences. The major premise may sometimes come formally to consciousness when there is some doubt about the conclusion, but usually the first and only thing to appear clearly in consciousness is the conclusion. We do not, therefore, proceed in the syllogistic manner in actual thinking. Both the syllogism of deductive logic and the methods of inductive logic are forms of proof for testing the truth or falsity of conclusions after they have been made. We must, therefore, distinguish between inference as the actual mental process which gives conclusions, and proof which is the method of logic for testing the results of reasoning. Logic deals with proof, not with the inner mental process of making inferences. Logic is, therefore, interested in arranging facts into ideal systems (logical concepts and judgments), in showing the necessary relationships which exist between these systems, and in giving methods of combining them (syllogism) for the purpose of testing the validity of our conclusions.

If we examine the reasoning process for the purpose of finding out how conclusions actually arise, we shall see, as we have already pointed out, that they arise through suggestions, both in the deductive and inductive processes. The rise of suggestions is controlled by the laws of association. Thus, if I am seeking material to kindle a fire, the moment my eyes fall upon paper the next thought is: "That's it, that paper will burn." The context of thought (purpose or plan) and the link of identity between the idea fire and the idea paper, determine the inference. The guidance of the reasoning process is found in the character of consciousness. What suggestions arise in a given situation depends upon the past experiences, range of information, sagacity, temperament, interests, purposes, and recent experiences of the individual, together with the context in which the problem for thought arises. The ability to pick out of a total situation the vital and important characteristics differentiates the mind of a Newton or a Darwin from that of the ordinary man. The law of association by similarity is most important in reasoning. The mind which easily detects identity among diversity, or sees delicate and subtle relationships of similarity, manifests very clearly the real mental process involved in inference. In order to detect identities among differences one must possess what James calls "sagacity or the perception of the essence of things," *i. e.*, the power to resolve total situations into their essential elements and "perceive" accurately what they contain—the power to discriminate and properly evaluate the elements of whatever is presented.

**Imageless Thought.**—It has been very generally assumed that the content, or actual mind stuff of our thinking processes, is derived from sensory experiences—that the original material of thinking comes from the various senses. The contents of a thought-process would then be either a sensation, or a group of sensations (perception), or images or memories of these sensations and perceptions. Even the relational elements between the terms of thought are considered by some psychologists to have a sensory content. Titchener believes that the content of relational consciousness is given by motor tendencies, or attitudes, whose representations in consciousness are faint kinæsthetic sensations or images. Miss Washburn, writing on this same point, says that the relational elements of consciousness are the remnants of remote ancestral motor attitudes. The relational experience represented by the word "but," for instance, is now the vestige of the kinæsthetic sensations originally set up in primitive organisms by simultaneous stimuli calling for two incompatible reactions at the same time. The experience, she says, was that of a certain suspended, baffled motor attitude. In short, the theory of sensationalism holds that all consciousness, even the elements of reflective thinking, can be traced back to sensations. Even those who do not go the whole length of sensationalism, *i. e.*, those who are not willing to admit that relational elements and meaning are reducible to sensations, have all along assumed that every thinking process does contain sensory and imaginal content, and that thought cannot take place without some substantive content of a sensory character either directly experienced or imaged. The "no thought without images" theory has been recently and vigorously attacked by a group of American and German psychologists who believe that they have discovered "imageless thought." They contend that thinking may go on without any imaginal, or sensory, content whatever. According to them thinking may be carried on, and frequently is in its highest forms, in terms of a "pure thought element." This non-imaginal thought element can be detected by introspection, if we accept the statements of the imageless-thought psychologists. They claim that, when we think, there are elements of thought present in the field of consciousness which are neither sensory nor affective in character, but which nevertheless constitute a content of consciousness. They claim further that this content may exist independently of sensations or images. Thus Woodworth says:[1] "According to my experience, the more effective the thinking process is at any moment, the more likely is imageless thought to be detected, provided only one introspects, which is not apt to be the case at such moments."

As an illustration of imageless thought we may quote the following from Woodworth's notes:[2] "While reading I heard some one playing on the piano a piece which I felt at once to be familiar, but which I did not at first identify. My first attempt at identification was felt to be wrong, and immediately afterward I identified it properly and with confidence. In doing so I thought of the first part of the piece (it was Chopin's 'Funeral March,' and the part being played when it caught my attention was the trio). Resting satisfied with my identification, I was about to turn to other things, when it occurred to me to ask whether, in identifying the piece, I had had its name present in the form of verbal imagery, and I found that I certainly had not; in fact, it required a moment's further thought to recall the sound of the composer's name and the name of the piece. Nor, in locating the trio as a trio and thinking of the character of the march proper, did I have an auditory image of the march. I regard the example as a good one, since the thought was perfectly overt, conscious,

[1] *Journal of Philosophy, Psychology, and Scientific Method*, III, 1906, p. 703.
[2] *Ibid.*, p. 705.

and definite, though it not only began but was completed without any image."

It is claimed that the pure-thought element shows itself plainly in cases where we are given a definite mental task to do, such as that required in a laboratory experiment. At each command to make a definite reaction we know exactly what we are to do and yet there is no imagery of any kind whatsoever. The thought of the act, or the response, or whatever the task may be, is perfectly definite, and yet it is imageless. It is also claimed that meaning may be present in the mind alone without any image or sensory experience. We have described a concept as an image of some kind, plus meaning. Now, the advocates of imageless thought contend that the meaning may exist in consciousness without the image. One may, they say, think of a thing purely in terms of its meaning without any visual, auditory, or other image of the thing.

The imageless "thought content, or element" has received various names in the different attempts to describe it. Some of the descriptive terms are: "conscious attitude," "determining tendency," "conscious predisposition toward," "problem" or "*Aufgabe*," "mental set."

The imageless-thought advocates have not succeeded in winning all psychologists to their point of view. Angell[1] and Titchener[2] have published very vigorous attacks upon the theory. It is generally contended that the "conscious attitudes" or "determining tendencies," constituting, according to the imageless-thought psychologists, the whole of thought at times, are merely conscious processes of perception or thinking which have become so habitual and automatic that the imagery involved has dropped into the background of consciousness and is, therefore, difficult to detect. In other

[1] *Psychological Review*, vol. 18, 1911, p. 295.

[2] "Experimental Psychology of the Thought Processes," 1909. See also an article by Book, "On the Genesis and Development of Conscious Attitudes," *Psychological Review*, vol. 17, 1910, p. 381.

words, cases of so-called imageless thought are cases where consciousness is shading off into the automatic and subconscious tendencies and reflex responses, where there is not only no imaginal content, but no conscious content distinct enough for introspection.

Roughly speaking, there are at the present time three groups of psychologists distinguished by their attitudes toward imageless thought. First, there are the sensationalists who believe that all thought processes are carried on in terms of sensations, or images, or both. They believe that meaning and relational consciousness are represented by sensory content of some kind. Second, there are those who accept the "directive tendencies" and "conscious attitudes" as phases or even contents of consciousness, but they believe that they are always attached to sensory, or imaginal factors and do not exist alone in consciousness. Third, there is a smaller group of psychologists who believe in the existence of a "pure thought content," independent of any sensory or imaginal content.

**The Neural Basis of Reason.**—We are not yet in possession of sufficient anatomical and physiological knowledge of the brain to be able to point out any specific cortical areas as thought centres. There are in the cerebrum very considerable areas which are not involved so far as we know in the reception of sense-impressions, or in the sending out of motor impulses. Two large areas in each hemisphere of the brain, one in the frontal region and one in the occipito-parietal region, commonly known as the associational areas, or Flechsig centres, have been thought to be involved in the higher thought processes. The frontal associational area especially has been considered as the higher centre or thought centre. This region is more highly developed in man than in any other animal, which fact has led to the belief that the frontal convolutions are the thinking areas. This is probably a good guess, although it is too general in character to be of any value. Without doubt, these associational areas contain neurones which mediate between the different sensory areas, and between the sensory areas and the motor areas, and so form centres of interconnection in the cortex. But just what particular brain centres are active in moments of ratiocination we do not know. It is very probable that the thinking process makes use of very wide-spread regions of the cortex, even including the sensory areas.

In cases where thought is not required to respond to a given presentation, reactions take place immediately and the nervous pathway from stimulus to response may be conceived as relatively simple and direct. But in other cases where thought is needed to bring the light of past experiences upon the present situation so that an intelligent response may be made, the impulses started by the stimulus may be conceived as shunted, or drained off, into larger areas than those involved in direct response. These larger areas may be thought of as higher centres in the sense that their activities correspond to larger and more highly systematized bodies of knowledge, meanings, and relationships, gained through past experience. When we realize that reasoning is not a separate kind of consciousness, or the immediate awareness of a given situation, but rather is the present consciousness augmented by the significance or essence of past experiences, then we shall cease to look for separate brain centres for thinking. On the other hand, we should expect the neural counterpart of reasoning to be a larger brain action, involving not only the limited neural action corresponding to the present-moment presentation, but also the centres corresponding to past perceptions, memories, and images. As larger and larger units of experience are awakened and incorporated into the present-moment consciousness, ever-widening waves of neural excitation must sweep over the cortex as the neural counterpart of thought. We must not forget, however, that such a conception of the matter is merely a conjecture with a very meagre body of fact to support it.

## CHAPTER XVI

## AFFECTION AND FEELING

So far we have been engaged in the task of analyzing and describing the mental states which give us our knowledge of the outer world of objects and relations. Sensations, perceptions, memories, judgments, concepts, and reasoning processes—all these forms of cognitive consciousness may be said to have an objective reference, in that they refer to things and relations in the outer world. We have now to examine those forms of consciousness which have subjective reference. We not only know objects and their relations but at the same time we are subjectively affected by them. The mental states containing certain attitudes aroused in us by the objects of our knowledge are called *feelings*. Thus a sensory experience may be pleasing or displeasing; we may like or dislike a particular person; feel joy or sorrow in the contemplation of certain facts; experience annoyance or anger in the action of a friend, etc. In its broadest psychological meaning, *feeling* is the term which denotes all those states of consciousness which are characterized predominantly by our affective attitudes.

**Affection.**—Feelings are complex conscious states consisting in sensory or ideational elements and the purely affective consciousness which these cognitive or ideational experiences arouse. When the affective consciousness predominates, the total conscious experience is called a feeling. The characteristic factor in feeling is *affection*. Affection is a unique and elementary content of consciousness always accompanying some cognitive process and never existing alone. Although affection is aroused by and accompanies cognition, it is easily distinguishable from the cognitive elements. Affection manifests itself in two qualities which stand in direct opposition to each other. A sensation, perception, memory, or other cognitive state may be (1) *agreeable* or (2) *disagreeable* when we experience it; *i. e.*, we are agreeably or disagreeably *affected* by it. Agreeableness and disagreeableness are the two elementary forms of affection. Pleasantness and unpleasantness are terms also used to designate these two forms of affection.

Some cognitive processes are pleasantly and some are unpleasantly toned, while some appear to be neutral in affective tone. With a medium intensity of stimulation the taste of sugar is pleasant, the taste of quinine is unpleasant, while certain other tastes are indifferent. Memories and ideas, judgments and reasons, in short, all forms of cognitive process may be pleasantly or unpleasantly toned. Some psychologists have been willing to stand for the statement that every cognitive process is accompanied by affection in some degree of intensity—that in the case of the apparently indifferent cognitive experiences the affection is so low in intensity that it is below the threshold of consciousness and so does not reveal itself to introspection. If, however, we credit the report of introspective observation, we are forced to admit that many cognitive experiences are neutral so far as affection is concerned.

**The Nature of Affection.**—When we go to the text-books for an answer to the question, What is the real nature of affection? we get a variety of answers. Some psychologists look upon affection simply as an attribute of sensation, just as intensity and duration are attributes. They refer to affection as the "pleasure-pain tone" or the "affective tone" of sensation. They think of affection as belonging to sensation, never as a separate affective process. The objection to this view lies in the fact that affection is an independent variable in its relation to sensation. It may or it may not accompany a given sensation, and some sensations are without affective tone altogether. Now, an attribute does not usually act in this way. If the intensity or duration of a sensation should be reduced to zero the sensation itself would disappear. This is apparently not true when its affective tone reduces to zero. Evidently affection is something more than an attribute of sensation. Moreover, affection has its own attributes —quality, intensity, and duration.

Other psychologists consider affection as a form of sensation akin to the organic sensations. The organic sensations are vague and undifferentiated, poorly localized, and have few, if any, definite qualities. They are, therefore, like the affective experiences. Pleasantness and unpleasantness may be, it is thought, organic sensations that are too indefinite and too diffuse for clear cognition. They are accordingly submerged or undeveloped sensations. Against this contention we may mention the fact that affection is found accompanying all kinds of sensations from the lowest organic sensation to the most highly developed visual sensations. This fact indicates that affection is not another kind of sensation but a unique conscious content different in quality from the sensory content.

Some of the earlier writers took an intellectualistic view of affection. Hegel, for instance, held that affection is an obscure kind of knowledge. Wolff thought it to be an intuitive knowledge of the state of the body. In this latter view the intellectualistic view of affection changes into a sensational view. Another and more definite form of the intellectualistic view of affection is that which considers affection as the relation of ideas, or sensations, to each other. In æsthetic experiences the harmony and balance of parts—the consonance of tonal sensations—are pleasing, while lack of harmony and balance of parts, and dissonance of tonal sensations are displeasing. The experience of relationship is a cognitive, not an affective process. The affective consciousness is something added to the cognitions. Although affection may be in some cases dependent upon the relation of sensations and ideas to each other, it is not itself a relation. Furthermore, affection is not always dependent upon the consciousness of relationship, it may also be connected with single sensations and ideas.

We have so far rejected the views (1) that affection is an attribute of sensation, (2) that it is a kind of sensation, (3) that it is an obscure kind of knowledge, (4) that it is a relation. What, then, is its real nature? In the opinion of the author the most satisfactory answer is that affection is a unique and elementary mental content, different from, but co-ordinate with, cognitive content. It is a new form of consciousness which, while dependent upon cognition, nevertheless plays its own particular part in our conscious life.

**Kinds of Affection.**—We have already stated that there are two elementary and opposite forms of affection: *pleasantness* and *unpleasantness*. All psychologists do not concur in this statement. Wundt, for instance, believes that there are in addition to pleasantness and unpleasantness two other pairs of opposing affections: *excitement* and *calm*, and *strain* and *relaxation*. This view is known as the "tridimensional theory of affection." He holds that these six forms of affection are not simple or elementary—that each has a large number of different qualities. There are accordingly many kinds of pleasantness, unpleasantness, etc. Titchener in his "Text-Book of Psychology," pp. 250–7, attacks Wundt's theory very vigorously. In the first place he points out that while pleasantness and unpleasantness are in every essential way opposites in nature, neither excitement and calm, nor strain and relaxation manifest in a true sense any such relation. On the other hand, relaxation is the minimum degree or lack of strain. Likewise calm cannot be thought of as the real opposite of excitement, but rather as the lack of excitement. Moreover, excitement and calm, or tension and relaxation may themselves be pleasantly or unpleasantly toned. How can this be if they are true affections? Wundt holds that the character of affection depends upon the attributes of sensation. Pleasantness and unpleasantness depend upon the intensity of sensations. Moderate intensities are pleasing while very low or very high intensities are unpleasant. Excitement and calm depend upon the quality of sensations, strain and relaxation depend upon the temporal attribute. If sensations are too slow or too rapid in developing, we experience strain, but if their time aspect is normal, we experience relaxation. Titchener thinks this view inadequate, in that it fails to take account of the spatial attribute of sensation. What kind of affection corresponds to the variations in our experiences of space? If the other attributes of quality, intensity, and duration have definite affective qualities depending upon them, why is extensity lacking in this respect?

That we have experiences that may be called excitement and calm, strain and relaxation, cannot be doubted. Many psychologists, however, believe that these experiences are cognitive and not affective in nature. Strain and relaxation are without doubt sensory experiences of the conditions of the muscular system (kinæsthetic sensations). Excitement and calm seem to consist in the awareness of the vividness and rate of change in our mental states plus certain kinæsthetic sensations. When excited our respiration and heart actions are disturbed. The normal rate of the physiological processes is changed and the general activity of consciousness is increased. The awareness of these changes constitutes the major part of the experience. It cannot, therefore, be considered as affective in character. Affection may, of course, accompany these cognitive processes, but the excitement is not the affection. In view of these considerations, we are forced to abide by our earlier analysis of affection into pleasantness and unpleasantness as the two elementary forms of affection.

**Attributes of Affection.**—The attributes of affection are quality, intensity, and duration. We have found that the fundamental qualities of affection are pleasantness and unpleasantness. In much the same way that one sensation differs from another sensation in quality, the affection pleasantness differs from the affection unpleasantness. Whether there is only one quality of pleasantness or unpleasantness, or whether there are many qualities, is a question that has not yet been settled among psychologists. Affection varies in intensity. An experience may be slightly pleasant or very pleasant. The same is true of unpleasantness. Affection also varies in duration. It may be momentary or it may continue for longer periods.

**Adaptation.**—Experiences tend to lose their affective character when long continued. Objects and events that are markedly pleasant or unpleasant at first, become indifferent later. A pleasing bit of color or a beautiful landscape will in time become indifferent to us if we continue to experience it. Likewise a disagreeable odor or the unpleasant manners of a friend will under the same conditions fail to affect us.

**Affection and Sensation.**—Since affection is dependent upon the cognitive processes, we shall expect to find it related in certain ways to variations in these processes. First of all we may note that the different modes of sensations do not arouse affection in the same degree. The more highly specialized sensations appear to have less affection than those that are not so highly specialized. For instance, the visual sensations are not as pleasing or displeasing as the olfactory or gustatory sensations, while the organic sensations have the most intense affections. Within the modes themselves affection varies with the quality, intensity, and duration of sensations. With the normal intensity and duration the qualities of some sensations are inherently agreeable or disagreeable. Thus some of the spectral colors are more agreeable than others. Tones of medium pitch are more pleasing than those of very high or very low pitch. Sweet is agreeable while bitter is disagreeable. Why some qualities of sensations are agreeable and some disagreeable is a question to which we shall return later.

Affection varies with the intensity of sensations. Sensations that are normally agreeable pass over into disagreeableness when the intensity becomes high. A tone of moderate intensity may be pleasing, but if the tone is increased in intensity it becomes disagreeable. With a continually increasing intensity most stimuli finally reach a point where the pain nerves are stimulated and the sensation of pain is aroused. The pain must not, however, be confused with disagreeableness of the original sensation. Sensations that are normally disagreeable become increasingly disagreeable when their intensities are increased. All sensations of very weak intensities appear to be disagreeably toned, but the affective tone may be due to the difficulty of attending to sensations of low intensities.

Sensations that are normally agreeable may become disagreeable if their durations are either too brief or too long. As in the case of very low intensities of sensations, very short durations may owe their disagreeableness to the processes of attention in these cases. Agreeable sensations have a definite duration during which their agreeableness is at its maximum. When adaptation sets in agreeableness passes into the region of neutrality and then into disagreeableness. Normally disagreeable sensations appear to remain disagreeable for all periods. They may, however, become less disagreeable through adaptation.

**Pain and Affection.**—The fact that pain-sensations are in almost all cases disagreeably toned has contributed to the popular belief that pain is disagreeableness itself. The expression "pleasure-pain tone of sensation," has been very widely used even in psychology. Pain, however, is not an affection, but a sensation. It is true that it is usually accompanied by the affection of disagreeablenes, but in a few cases where the pain-sensation possesses a very low degree of intensity it may be neutral or even agreeable. Slight stimulation of certain parts of the body by an electric needle give rise to fine pain-sensations that are of an agreeable character. Charged beverages owe their agreeableness partly to the delicate pain-sensations aroused mechanically by the presence of gas in the beverages.

Pain, then, offers no exception among sensations in its relationship to affection. Popular thought does not easily accept this view, for the reason that we do not ordinarily consider a stimulus painful until it is accompanied by disagreeableness,—hence the confusion in ordinary thought between the sensation of pain and the affection of disagreeableness.

**Affection and Perception.**—Since the perception of an object includes the presentation of several sensory qualities the affective tone accompanying the perception is the complex of the affections belonging to the several sensations within the perception. Some aspects of the total object may be pleasing while others may be neutral or displeasing. Whether the resulting affection really is a complex made up of parts, or whether it is a unitary and unanalyzable content accompanying the total perception process, is a question for future determination. Do the different sensations pool their affections, or is there a single affection depending upon the perception?

**Affection and the Ideational Processes.**—Not only does affection accompany sensory elements and perceptions, it also accompanies ideational processes. Memory, imagination, and reasoning processes may be agreeable or disagreeable in themselves. But since these ideational processes take place in an organism that is always receiving sensory stimuli of some kind, either from the outer world or from the organic processes within, it is sometimes difficult to determine how much of the total affection is due to the ideational process and how much is due to the sensory experiences. We cannot, however, question the fact that the higher and centrally initiated processes are in themselves affectively toned. A memory act may be agreeable or disagreeable. It may or it may not have the same quality of affection that belonged to the original experience. Oftentimes experiences that are originally pleasing are, when remembered, decidedly unpleasant. Whether a memory act is pleasant or unpleasant is determined by the relation of the recalled experience to the contents of consciousness at the time. If it stands in opposition to our present purposes, desires, and ideas, it will be unpleasantly toned, but if it is in conformity to them it will be pleasantly toned. Images and concepts also conform to this general rule. It is doubtful whether affection possesses a memory of its own. Can we image and reinstate our affections as we do our cognitive states? We can remember that certain past experiences were agreeable or disagreeable, but this process is purely cognitive, not affective. Memory involves imagery, and images are possible only as cognitive products. Affection is always a first-hand product, arising fresh from the nature of the cognitive processes at the present moment and never the image or reproduction of a previous state.

Over and above the affective states which accompany the separable cognitive elements in the intellectual process, a further affective coloring may adhere to the thinking process itself. Here the same general principle, which we found governing the affective states in memory and imagination, holds in the processes of thought. Reasoning processes which aid our purposes, interests, and desires, are agreeably toned, while those which oppose them are disagreeably toned.

**Affection and Bodily Expressions.**—Attempts have been made to find the characteristic bodily reactions which are connected with agreeableness and disagreeableness—such bodily reaction as changes in circulation, respiration, secretions, digestion, and involuntary movements. Changes in respiration during both agreeable and disagreeable experiences have been studied by means of the pneumograph—an instrument which records the rate and depth of breathing. Variations in the pulse have been recorded by the sphygmograph, and changes in the volume of the arm or other members of the body by the plethysmograph. The results of these studies of the bodily expressions connected with pleasantness and unpleasantness are conflicting. Changes in respiration, heart-beat, gland activities, and involuntary movements have been observed during the experiences of pleasantness and unpleasantness. Breathing may be increased or decreased in rate and depth, the pulse may be quickened or slowed, strengthened or weakened, etc., but no one set of these changes is found to take place uniformly with either one of the affections. More recently the galvanometer has been used to detect the presence of electrical currents in the body during affective experiences. The discovery of these currents in the body was thought to be the beginning of a new era in the study of the expressions of affective and emotional states. Cognitive activity was found to be accompanied by only slight electrical changes while affective states manifested their presence much more markedly. But when we consider that muscular activity may produce electrical changes similar to those found accompanying affective states we must conclude that electrical phenomena are not distinctive marks of affective expression. Moreover, these electrical changes do not differ in character for the two forms of affection. Later investigations indicate that the action of the sweat-glands have something to do with the electrical changes recorded by the galvanometer. Increased humidity of the bodily surfaces would certainly favor the passage of electrical currents from one part of the body to another.

In regard to the grosser form of expression and behavior accompanying affective states, ordinary observation has little difficulty in detecting the difference in the facial expressions and bodily attitudes which attend the affective state of pleasantness and those which attend the affective state of unpleasantness. We know immediately when our friends are pleased and when they are displeased. In a general way we may say that pleasurable experience tends to bodily movements of expansion and approach, while unpleasant experiences tend to movements of contraction and withdrawal.

There can be no question but that all the vital processes, even those of assimilation, secretion, and excretion, are influenced during affective experiences; but, beyond the very general statement which we have already made, we are unable to formulate any law which governs the affective bodily expressions.

**Neural Basis of Affection.**—Sensations depend upon the action of specific nerves and brain centres. There are, however, no special end-organs and brain centres for pleasantness and unpleasantness. What, then, is the neural basis of affection? We have no exact detailed knowledge to offer in answer to this question. We must, therefore, resort to theory. It seems probable that affection depends upon the mode in which neural activity goes on in any particular part of the nervous system, or upon the way in which the neural activity in any one part affects the other parts of the nervous system or the nervous system as a whole. Normal and efficient reaction of the neural mechanism in any particular segment corresponds to pleasantness, while excessive or inefficient reaction corresponds to unpleasantness. This would explain the disagreeable character of very high and very low sense intensities.

We must admit that this principle is difficult to apply in cases where unpleasantness is due either to the quality of sensations or to ideational processes. Why, for instance, is the moderate intensity of bitter unpleasant? Or why is the perfectly clear and definite thought of a friend's disloyalty unpleasant? In the case of the sensation bitter we may suppose that the nerve-tissues involved are not adapted to the stimulus—that the nerve-currents caused by the stimulus are of such a nature that they meet resistance in the nervous tissue of the sense pathways and centres. In the case of the thought of the friend's disloyalty the resistance would be found in the association paths and centres. Thus the theory of resistance may be applied to all cases of affection accompanying both sensory and ideational processes. Ziehen proposes such a theory. He holds that the normal and efficient discharge of nerve-currents from any part of the brain, along paths of projection, or paths of association, is the neural counterpart of pleasantness, while any obstruction of such discharge is the counterpart of unpleasantness. In short, pleasantness goes with facilitation and unpleasantness with inhibition of neural activity. It is interesting to compare with this physiological theory of affection the old intellectualistic theory that pleasantness is the awareness of the harmonious co-operation of ideas, and that unpleasantness is the awareness of the conflict between ideas—in other words, that affection is brought about by the facilitation and inhibition of ideas among themselves. Since we are committed to the hypothesis that every form of consciousness has a neural basis of some kind, we must, therefore, consider the neural as well as the mental conditions under which affection arises. The conditions of resistance affecting the mode of activity in nerve pathway and centres may then be taken as the neural basis of affection. Many other theories have been proposed. Bain's statement of the case may be translated into neural terms. He says that "states of pleasure are connected with an increase, and states of pain with an abatement, of some or all of the vital functions." This, of course, is true in many instances, but it does not always hold. Cases may be found where pleasure is the accompaniment of lessened vital functions.

Titchener thinks that the free sensory nerve-endings found throughout the different tissues of the body are the peripheral organs of affection. They represent, he thinks, "a lower level of organic development than the specialized receptive organs, or organs of sense. Had mental development been carried further, pleasantness and unpleasantness might have become sensations—in all likelihood would have developed into a number of sensory qualities." Back of this hypothesis lies the theory that sensations and affection have both developed from a common mental ancestor—a kind of undifferentiated consciousness. He says that "the affections appear—not exactly as undeveloped sensations—but at any rate as mental processes of the same general kind as sensations, and as mental processes that might in more favorable circumstances have developed into sensations."

The exact function of the free nerve-endings is in dispute. We have in our treatment of sensation considered them as sense end-organs whose stimulation results in pain. There is nothing impossible, however, in the supposition that there are undifferentiated free nerve-endings within the tissues of the body which may give rise to certain affective experiences. It is, however, difficult to see how the affections accompanying ideational processes can be accounted for by such nerve-endings.

Certain writers connect affection with the action of special cortical centres in the brain, others, like Meynert, connect affection with the nutritive condition of the brain. But where definite facts are wanting it is useless to attempt to evaluate these theories. Lehmann considers pleasantness correlated to the proper balance between the supply and the expenditure of energy by the nerve-cells in the brain; while unpleasantness is the correlate of an excess of expenditure over supply. Very intense stimuli are disagreeable because they overwork the brain-cells and call for a greater expenditure of nervous energy than can be supplied by the nutritive process in the centres involved. Münsterberg suggests what he calls the "action theory" of affection. Pleasantness is the correlate of central brain activity which is starting bodily movements of approach, while unpleasantness is the correlate of central brain activity which is starting movements of withdrawal. Affection, therefore, is the conscious accompaniment of central brain processes connected with the arousal of movement impulses.

**The Significance and Function of Affection.**—When we review the facts of our affective consciousness we see that we are justified in believing that pleasantness is correlated with those conditions both within and without the organism which make for its welfare; while unpleasantness is correlated with those conditions that menace its welfare. In the main whatever is *immediately* beneficial is agreeable and whatever is immediately harmful is disagreeable. In a complex organism like that of man the application of this principle meets with many difficulties for the reason that sometimes what is beneficial to some one phase of his existence is harmful to another, and what is helpful for the immediate moment is detrimental in the long run. Affection, then, may be looked upon as an index of the immediate conditions that are beneficial or harmful to the organism.

There seems to be no doubt of the fact that pleasantness determines appetition—the tendency to hold to certain stimuli and continue certain experiences, and that unpleasantness determines aversion—the tendency to withdraw from certain stimuli. The reactions involved in appetition and aversion are the most fundamental and significant selective reactions of the organism. It may be true that in man's higher development some of his reactions are not determined by the agreeable or disagreeable, but in his primitive forms of behavior, at least, he seeks the pleasant and avoids the unpleasant. If, now, the pleasant is connected with the beneficial and unpleasantness with the harmful, we can see of what far-reaching biological significance the affective consciousness must have been in organic development. Organisms which in the beginning sought the pleasant must have had a tremendous advantage over those which did not. To the question as to how the connection between the beneficial and the pleasant experiences was established we are unable to offer an answer in psychology. That is a question which the biologists have not yet settled. Were the first organisms as likely to seek stimuli giving unpleasant experiences as those giving pleasant experiences? Did natural selection by killing off those who sought the unpleasant establish the tendency in the race to seek the pleasant? If this is true then we must suppose that the relation between the pleasant and the beneficial and between the unpleasant and the harmful stimuli was already established in the very beginning. Some psychologists, perhaps, would prefer to disregard consciousness altogether as a factor in evolution. Natural selection would then preserve those organisms which happened to seek beneficial stimuli and eliminate those that happened to seek harmful stimuli. Consciousness in such a scheme would have nothing to do with organic development. In this case the tendency to seek the beneficial and avoid the harmful must have grown up through natural selection independently of the consciousness of pleasantness and unpleasantness. It is, however, inconceivable that so important a factor as consciousness has had nothing to do with behavior. We cannot give up the principle previously postulated, viz.: that the affective states of pleasantness and unpleasantness have been and still are in a large measure efficient factors in the struggle for existence. We are willing, therefore, to accept the hypothesis that beneficial stimuli were from the very first capable of giving the experience of pleasantness and harmful stimuli the experience of unpleasantness.

**Feeling.**—While feeling is a complex mental state containing cognitive elements, the predominating character of the experience is given to it by its affective components. Pain, for instance, although a sensation, is often properly spoken of as a feeling, because the total experience is predominantly affective. Hunger too may be referred to as a feeling when we mean to include the affection accompanying its sensory process. Many of the organic sensations are commonly considered to be feelings because the sensory qualities in the experiences are so vague and unclear that, failing to occupy attention, they allow the affective consciousness to outweigh them in the total experience. Not only do sensory elements form nuclei for feelings, but memories, images, and trains of thoughts are oftentimes so deeply submerged in affective consciousness that the experiences may be termed feelings.

Since sensory and ideational processes of various varieties and in many degrees of intensities and duration may combine with the different qualities of affection, it is evident that the number of different feelings that the human mind can experience is infinitely great. They may vary from the very simple feelings involving only a single sensation, percept, idea, or thought to the most complex feelings involving highly complicated combinations of sensory and ideational elements and mental activities. The feeling of hunger, of pain, or that aroused by a pure spectral color or by the thought of honesty are simple feelings, while that aroused by a symphony, the Sistine Madonna, or by the tragedy of "Hamlet" are very complex feelings. Feelings may also vary from the relatively pure to those that are highly mixed. All the elements in a situation may arouse the same kind of affection. On the other hand, some of the elements may be disagreeable while the others may be agreeable. The resultant feeling in the first case is pure while the feeling in the second case is mixed. The feeling aroused by a beautiful landscape is pure. Every part of the whole—the several objects, colors, etc.—is agreeable, as is also the synthesis of these parts into the whole. But the feeling which stirs us when we contemplate Shakespeare's tragedy "Hamlet" is a mixed feeling; for while some of the separable contents of our thought are unpleasantly and some pleasantly toned, the artistic combination of the parts into a whole may produce a decidedly pleasant effect. It is evident that the complex feelings may be either pure or mixed accordingly as they contain affections of the same or of different qualities. The simple feelings are always pure feelings.

**Classification of Feelings.**—The classification of the feelings based only upon the quality of affection which enters into them gives just two kinds of feelings: Pleasant and unpleasant feelings. But if we employ other bases of classification, many kinds of feelings may be made out. In view of the great number of combinations that may occur between the elements of affection and the different qualities and intensities of sensations and of ideational processes, it is impossible to make any adequate classification of the feelings. We can suggest only a few very general divisions.

As we have already seen, if we think of the degree of complexity into which the component parts of feeling enter, feelings may be *simple* or *complex;* or pure and mixed if we consider the homogeneity or heterogeneity of the affection qualities which enter into the combination.

Certain vaguely localized and obscure organic sensations have sometimes been spoken of as *sensus communis* or "common feelings." These sensations arise from changes in blood-supply in the capillaries about nerve-endings, from the physiological condition and action of heart, lungs, glands, and other internal organs—in short these sensations constitute the vague awareness we have of the condition of inner organic processes. This awareness is never raised to definite and clear presentations of sense and for this reason the sensations referred to appear to be almost entirely affective in nature. They do possess affective tone and the mixture of obscure sensations and affection result in the common feelings. Feelings of well-being, of high spirits, of depression, of gloom and despondency belong to this class of common feelings. Although they usually remain in the background of consciousness, they may give tone and color to the entire stream of consciousness. They are not only important in determining our moods but they also contribute very largely to the consciousness of self. Temporary and often slight functional disturbances in the vital processes may result in a personal "feeling of strangeness" or a "feeling of not like ourselves" without our knowing why. The common feelings are differentiated from the feeling which arises in connection with the special senses, or with the ideational process, by the obscureness of their cognitive elements.

Feelings may be classified into *sensuous* and *intellectual feelings* accordingly as their cognitive contents result from the sensory or the ideational processes. But since ideational processes depend upon and involve sensory elements this classification is not a very valuable one.

If we were to classify the feelings according to the nature of the cognitive states which enter into them, the list of feelings would be as long as that of the cognitive states themselves. Some of our presentations and trains of thought, however, are especially prolific in producing affective states. Æsthetics, ethics, social relationships, and religion involve presentations, ideas, and thoughts which enter into feeling complexes. It is suggested, therefore, that we classify feelings into *æsthetic feelings*, *ethical feelings*, *social feelings*, and *religious feelings*. This, however, is a very partial and incomplete classification. There are many other cognitive experiences which are capable of arousing affections.

**Mood.**—We often find that for considerable periods of time the stream of consciousness is permeated by a more or less persistent affective tone. All our presentations and thoughts are temporarily colored by a certain affective attitude. This predisposition to feel in a certain way is known as mood. For hours after receiving a bit of good news we may be dominated by the feeling of cheerfulness. Even disagreeable experiences are transformed and lose their irritating character under the spell of this mood. On the other hand, bad news or an especially irritating experience may leave us with the "blues." Moods are not only the after-effects of past events and past feelings, but they may be induced by intra-organic conditions. Blooming health predisposes to cheerfulness, while indigestion or other physiological disturbances may depress us and make the whole world seem out of joint. Sometimes we pass from one mood to another very quickly, at other times the change takes place very slowly.

**Temperament.**—While mood is a temporary disposition to feel in a certain way, *temperament* is a fixed and permanent predisposition toward a definite form of affective response.

Individuals differ markedly in this respect. Some are so constituted that everything appears in a gloomy and melancholy light, while others are constitutionally predisposed to view everything in the brightest hues. These differences in temperament are probably due to hereditary factors and represent in each individual permanent tendencies in his feeling attitudes. A very old and well-known classification of temperaments divides them into four classes accordingly as their feeling responses are quickly or slowly aroused and whether they are intense or weak in character. These forms of temperament are *choleric*, *melancholic*, *sanguine*, and *phlegmatic*.

The choleric temperament has quickly aroused and intense feelings, the melancholic has slowly aroused and intense feelings, the sanguine has quickly aroused and weak feelings and the phlegmatic has slowly aroused and weak feelings.

**Emotions.**—There are certain complex and mixed feelings possessing a high degree of intensity and vividness, which are known as emotions. They might be referred to as feelings of agitation. They are conditioned by a series of widespread and diffuse organic excitations, conflicting instinctive impulses, and habitual types of reaction. On the cognitive side they contain the perception or ideation of certain exciting objects and events plus a mass of kinæsthetic and organic sensations which are aroused by the organic excitation and the conflicting instinctive impulses and reactions. The affective states accompanying these various cognitive states entering into the total complex are, therefore, numerous and conflicting. In all the other feelings the stream of cognitive consciousness is not especially disturbed—the various processes of presentation and currents of thought go on more or less smoothly and without marked interruption, but in emotions there is a sudden stoppage in all the avenues of mental activity. Especially is there a blocking of the higher cognitive activities. We are seized, as it were, by emotions. The neural excitement caused by an emotional object or event fails to be adequately drained off through the usual channels of adjustment. As a consequence the nervous energy aroused is turned back into the organism and diffused throughout the organic and motor pathways, thereby causing a condition of conflicting bodily impulses. Anger and fear are typical emotions. Since we shall study the emotions more carefully in the next chapter, we shall give no more space to their consideration here. We have mentioned them only to point out their place among the feelings.

**Sentiments.**—Sentiments are relatively permanent feelings which grow up around more or less complete systems of ideas and intellectual processes. A sentiment might be called a frame of mind colored and supported by affective consciousness. Baldwin's "Dictionary of Philosophy and Psychology" defines sentiments as "emotional dispositions having reference to an object or class of objects represented by a more or less complex system of ideas." They are, however, milder and more enduring feelings than emotions. They are feelings which are based upon and include a more rational cognitive process than emotions. They vary, however, in this respect, sometimes more and sometimes less of the rational element being present. They may at times under certain circumstances rise to the same intensity and take on the irrational and agitating character of emotions. Love, for instance, is both a sentiment and an emotion. As a sentiment it includes a rationalized system of ideas and the affective tone which attaches to the ideas. As an emotion these ideas temporarily sink into the background while we are thrilled in every nerve by the object of the emotion. Friendship is a typical sentiment. Here we find the mental presentations of the personal virtues and characteristics of the object of friendship and the experienced conformity of these characteristics to certain ideals which have been formulated and fixed in our minds. A sentiment is not experienced in its entirety at any one moment; it follows in its activity the sequence of ideas which centre about its object and so only one phase of the sentiment is active at a time. In so far, however, as we are able to unify all the various ideas into a single concept, the sentiment too may be unified into a momentary experience.

Since sentiments form about relatively stable centres of ideas and intellectual processes, we may expect to find most authorities classifying them according to certain fields of experience in which we have established ideals, or norms. We have, for instance, ideals of truth, of right, of beauty, and of the Absolute. Ideational constructions which are conformable or non-conformable to such ideals would constitute the bases for the different kinds of sentiments. Accordingly, sentiments are divided into (1) *intellectual* or *logical*, (2) *ethical* or *social*, (3) *æsthetic*, and (4) *religious* sentiments. Among intellectual sentiments may be mentioned those of belief and disbelief, of truth and falsehood, of agreement and contradiction. The ethical sentiments include those of friendship, hate, pride, freedom, and gratitude. The æsthetic sentiments include the sentiments of beauty and ugliness, of sublimity and tragedy. Among the religious sentiments are those of awe, reverence, faith, and remorse.

**Passion.**—The term passion is very loosely used in ordinary speech. Sometimes it may refer to a sentiment; as when we say that one has "a passion for painting." Sometimes it refers to a strong and uncontrolled emotion. In psychology the second usage is prevalent. But really no sharp line between emotions and passions can be made out. We speak of an emotion as a passion when it takes possession of us to such an extent that all our powers of voluntary control are inhibited.

## CHAPTER XVII

## EMOTIONS

In the preceding chapter we said that emotions are highly complex feelings. While a simple feeling manifests only a single cognitive element and its affective accompaniment, emotion, on the other hand, is a highly complicated and diffused reaction of the whole conscious organism in which many cognitive and affective elements are fused together. Before elaborating this theory of the emotions we may profitably examine a very suggestive theory of emotions proposed in this country by William James and in Europe by C. Lange, professor of medicine in Copenhagen. These writers, working independently of each other, came to practically the same conclusions. For that reason the theory is known as the "James-Lange Theory of Emotions."

**James-Lange Theory of Emotions.**—Speaking of the emotions of grief, fear, and anger, James says: "Our natural way of thinking about these coarser emotions is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression. My theory, on the contrary, is that *the bodily changes follow directly the perception of the exciting fact, and that our feeling of the changes as they occur is the emotion.* Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike. The hypothesis here to be defended says that this order of sequence is incorrect, that the one mental state is not immediately induced by the other, that the bodily manifestations must first be interposed between, and that the more rational statement is that we feel sorry because we cry, angry because we strike, afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be. Without the bodily states following on the perception, the latter would be purely cognitive in form, pale, colorless, destitute of emotional warmth. We might then see the bear, and judge it best to run, receive the insult, and deem it right to strike, but we should not actually *feel* afraid or angry. . . . No reader will be inclined to doubt the fact that *objects do excite bodily changes* by a preorganized mechanism, or the further fact that *the changes are so indefinitely numerous and subtle that the entire organism may be called a sounding-board*, which every change of consciousness, however slight, may make reverberate. . . . *Every one of the bodily changes, whatever it be, is felt acutely or obscurely*, the moment it occurs."[1]

This statement makes emotion a group of organic sensations reflexly excited by the emotional object or situation. No place is given in the theory to the various shadings and combinations of the affections of pleasantness and unpleasantness which enter into and give affective character to the feelings. The theory also denies the very widely accepted belief that the primary central excitation reaching the brain from external objects or events is the basis of emotion. Neither the perception nor the ideation of an emotional object or event is in itself able to arouse an emotion. Not until the secondary stimulation or organic back-flow reaches the central brain areas does the emotion arise. The theory, therefore, calls attention in a unique way to two very important facts which have been neglected by the common-sense view of the emotions. In the first place, we must agree that exciting facts and situations (emotional stimuli) do set up instinctive reflexes in the vital organs and in the muscles of the body. The sight of a wild beast causes us to start and tremble before we have had time to image the danger. The shortened breath, the pallid face, and the "heart jumps" are immediate instinctive reflexes which precede the feeling of terror which

[1] "Principles of Psychology," II, pp. 449–451.

seizes us. The proffered insult immediately closes our fists and sets our teeth. The piece of bad news reflexly causes the lachrymal effusion. The embarrassing situation causes the reflex of swallowing, of clearing the throat, or of incipient coughing. As James says: "Emotional objects are certainly the primitive arousers of instinctive reflex movements." In the second place, we do sense these bodily reverberations as organic and kinæsthetic sensations, sometimes acutely and sometimes obscurely, during the course of the emotion. We, therefore, agree that these bodily reverberations are important elements in the make-up of the emotional seizure. We hold, however, that the theory is illogical in that it takes a part for the whole. Can we agree to the statement that the complex of organic and kinæsthetic sensations is the emotion?

James proposes two lines of argument in support of his theory. The first one is as follows: "*If*," he says, "*we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of the bodily symptoms, we find we have nothing left behind*, no 'mind-stuff' out of which the emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains. . . . What kind of an emotion of fear would be left if the feeling neither of quickened heart-beats nor of shallow breathing, neither of trembling lips nor of weakened limbs, neither of goose-flesh nor of visceral stirrings, were present, it would be quite impossible for me to think. Can one fancy the state of rage and picture no ebullition in the chest, no flushing of the face, no dilatation of the nostrils, no clenching of the teeth, no impulse to vigorous action, but in their stead limp muscles, calm breathing, and a placid face?"[1] James asserts that he can imagine no such condition—that without the first set of bodily excitations "the rage is as completely evaporated as the sensations of its so-called manifestations" and that the only thing that can take its place is a cold-blooded cognitive con-

[1] "Principles of Psychology," II, pp. 451–452.

sciousness. He goes on to say: "A purely disembodied human emotion is a nonentity. I do not say that it is a contradiction in the nature of things, or that pure spirits are necessarily condemned to cold intellectual lives; but I say that for *us*, emotion dissociated from all bodily feeling is inconceivable." Critics have already pointed out the illogical nature of this argument. The bodily organic sensations might well form an important or necessary part in emotion and yet not be the emotion. It may be impossible for emotion to exist without the organic reverberations, but it does not follow that these reverberations constitute the whole emotion.

The second line of argument is based upon certain pathological cases found in insane asylums in which emotion is objectless—*i. e.*, cases where persons are seized by morbid fear or other emotion without cause. Either during or after the attacks the patients are unable to give any reason for the emotion. They are simply seized at times by uncontrollable fits of fear. Other unmotived emotions—anger, melancholy—may also manifest themselves and persist without cause. If, according to James, the patient is unable on account of some pathological nerve condition to take a full breath, has fluttering of the heart and visceral disturbances, and manifests an irresistible tendency to take a crouching position, the combination of the resulting organic sensations makes up the emotion of morbid fear. Assuming that in such cases the experience is a true emotion, there may be ways of explaining it without taking it for granted that the combined group of organic sensations is the emotion. First of all, the patient in his previous experience may have had "fear thoughts," or real or hallucinatory presentations of threatening things. Since the organic sensations mentioned would be on these occasions a part of the emotion, an associative connection would be set up between the organic sensations and the real or imagined fear presentations. We can readily understand, then, how the recurrence of this set of organic sensations can awaken the associative connections and make active the predisposition to the same emotional consciousness. The organic factor need not awaken the former presentations completely. These presentations may not rise to full consciousness at all, but remain in the background as vague forebodings, or indefinite and shadowy forms of threatening things which remain hidden from the patients' introspection. Or, the organic sensations may be supplemented by meaning. In the past experience of the patient, they may have come to stand for fearful things in general. Again, we may of course refuse to accept the assumption that the pathological unmotived fear is the same as the real emotion of fear. It may be only a remnant of the real emotion. These cases, therefore, fail to furnish proof that the organic sensations are in themselves the emotion.

On the other hand, attempts have been made through experiments upon lower animals to show that the organic sensations are not necessary to emotions. Sherrington, for instance, by severing certain nerves in dogs, cut off all sensations coming from the viscera, skin, and muscles behind the shoulder. These animals showed no loss of emotions after the operation, so far as could be observed. This, however, is not conclusive. In the first place, we know very little about the "inner" consciousness of animals. We can only observe their outer behavior. Who can tell whether the dog's affective experiences were the same after the loss of the organic sensations? The outward behavior and organic responses may have manifested no observable difference, but we must remember that these responses are reflex movements and might very well take place, even though their resulting sensations were not aroused in the animal's consciousness. In the second place, even if we agree that the emotions are present after the elimination of the organic sensations, the images or "memory" of these sensations may still be aroused by virtue of the associative connections formed in previous experiences.

Another objection to the theory has been offered by its opponents. The objection is founded upon the fact that different emotions may manifest the same bodily expressions. Thus we may cry in extreme joy as well as in sorrow, or tremble in anger as well as in fear. If, say the critics, the emotion is the report in consciousness of bodily expressions, then the quality of emotions must be determined by the character of the expressions. How, then, can the same expression be experienced in such different ways? Also, it is urged, the same emotion may manifest on different occasions very different bodily expressions. Thus at one time in fear we may crouch and hide while at another we may run away. How, then, can these quite different bodily expressions be experienced in the same way? In reply to these objections it may be said that a single expression does not determine the character of the emotion. It is rather determined by a complex of bodily expressions. Crying in sorrow is not its only, or even its fundamental expression. Other more deeply seated organic reactions give it its character. Surely there may be certain variations in the expressions of an emotion without destroying its general character. Unhappily no one has yet determined the exact character of the bodily expressions in emotion, or made out any uniform correlation between the emotions and their expressions. Shepard, who has made a very careful study of the changes in circulation and breathing during affective conscious states, concludes that no classification of the feelings can be made on the basis of their bodily expressions.[1] We cannot, therefore, be dogmatic. We must wait for further evidence.

It is a commonly accepted hypothesis, and the facts so far as we know them indicate that *affection* arises from central brain processes which also give rise to experiences of sensory or ideational character.[2] Visual, auditory, gustatory,

[1] *American Journal of Psychology*, 1906, XVII, p. 522.

[2] There are some divergent views, however. Münsterberg, for instance, considers that the affective states of pleasantness and unpleasantness are the

and olfactory stimuli, as well as organic and kinæsthetic stimuli arouse affective consciousness. If this is true, and if emotions are complexes of cognitive and affective consciousness, then not only do organic and kinæsthetic sensations contribute to their make-up, but all the other forms of consciousness contribute their part, too. There is no reason to suppose that the organic sensations alone have the power to arouse emotional experiences.

It may be that the back-flow of organic sensations is a very important factor in emotions, or even that its presence makes the difference between the stronger emotions and the simpler and calmer feelings. The agitating nature of emotion is due, without doubt, to the presence of organic disturbances. But in both cases (that of simple feelings and of the stronger emotion) the manner in which the sensory or cognitive stimuli enter and affect the central areas gives rise to the distinctive affective components in the emotion.

The chief difference, therefore, between the theory as originally outlined by James and the theory which is supported here lies in the number and kinds of cognitive states admitted into the emotion; and in the value placed upon the affective elements as component parts of the emotion. James limits the emotion to the consciousness of the organic disturbance, or bodily resonance, set up reflexly by the emotional stimulus. We believe, on the other hand, that the perception of an emotional object or event and the ideational processes which are awakened by the perception as well as the mass of organic sensations aroused by the bodily reflexes

mental correlates of nerve-currents which reflexly excite muscular movements of extension and contraction. If the movements are not reflexly excited they are reported in consciousness as kinæsthetic or muscular sensations, but if they are reflexly excited they appear as affection. This would appear to furnish a basis for the James-Lange theory. Organic disturbances set up through reflex and instinctive pathways would be reported back to consciousness as an emotional complex. There is no evidence, however, that James had any such hypothesis in mind. On the other hand, he considered the organic rebound as a sensory process.

enter into the emotional complex. In addition, we believe that the various affective accompaniments of these cognitive factors also help to determine the character of the emotion. All these components form a synthetic unity, which we call emotion.

It is fair to say that James has modified the original statement of his theory somewhat. This modification consists in the first place in the admission of the affective nature of the perception which starts an emotion. Either pleasantness or unpleasantness, he admits, may inhere in the sensations and be fused into the perception, thus forming part of the whole. In the second place, he has amplified his first statements by explaining that it is not the perception of the simple object alone that initiates emotion, but the perception of a total situation of which the object is a part. The object may in time, after we are familiar with its context, become capable of suggesting the total situation and the suggestion may start the emotion.

**The Instinctive Reactions and Emotions.**—If we consider a list of the most important instincts we shall find that they all manifest an emotional aspect. For instance, fear is both an instinct and an emotion—an instinct in so far as it is a tendency leading to native forms of motor reactions, such as flight, crouching, or hiding—an emotion in so far as it is a feeling. Pugnacity and anger, curiosity and wonder, parental instinct and tender emotion are other pairs of terms, the first of which stands for an instinct and the second an emotion. Instinctive situations tend to set up emotions as well as instincts. On the other hand, emotional stimuli tend to arouse instinctive reactions. The instincts which are strongly marked by an emotional counterpart, like those of anger and fear, manifest, in addition to their outward acts, motor reactions which affect the inner organic processes. The instincts which are less marked by emotional tone, like those of play and imitation, manifest little or no tendency to disturb the inner organic processes. All of their energy is consumed in acts which affect outer objects. In so far, then, as an instinct initiates motor impulses which affect primarily the organism, it gives rise to emotion, but in so far as it consists in acts which change the environment or in acts which adjust the organism properly to the environment, we think of it only as an instinct.

If we ask why certain instinctive impulses are thrown back into organic channels instead of into the more evident environmental adjusting mechanism of the body, we may find an answer in certain biological theories. The student must judge for himself the value of these theories. Why, for instance, does the mouth become dry and the skin moist with perspiration in fear? Why do we tremble when confronted with a fearful object? The answer which has been commonly given in explanation will be more evident if we consider some of the other instinctive reflexes found in fear. For instance, we start and crouch and shrink into ourselves when frightened. The movements are the initial stages of running or jumping away, and of hiding from the threatening object. The movements of running away and hiding have been very useful to the organism in just such circumstances. Therefore, the starting and crouching and shrinking in fear are supposed to be weakened repetitions of useful acts. Accordingly, all emotional reactions which are not now plainly useful are looked upon as organic survivals of acts that were once useful and adaptive reactions in racial development. They are reminiscent of past struggles for existence. The disturbances in heart and lung action which are present in fear are repetitions of the quickened heart-beat and breathing needed in flight or combat. "Fear," says Spencer, "when strong, expresses itself in cries, in efforts to escape, in palpitations, in tremblings; and these are just the manifestations that go along with an actual suffering of the evil feared. The destructive passion is shown in a general tension of the muscular system, in gnashing of teeth and protrusion of the claws, in dilated eyes and nostrils, in growls;

and these are weaker forms of the actions that accompany the killing of prey.'' Distention of the nostrils in anger, Spencer thinks, is a survival of the manner in which our ancestors had to breathe during combat. Many emotional expressions have been traced back to early utilitarian adaptations. Trembling in fear may have been an instinctive movement preparatory to actual flight. The quickened breath of anger harks back to the times of hand-to-hand conflicts with an enemy. Clenching the teeth and opening the lips, which is now often observed in angry men, is a survival of those early struggles in which the teeth were used for attack. Opening the mouth in astonishment was useful in that it aided in attentive listening. Blushing of the face and neck, according to Wundt, serves the purpose of relieving the brain of blood-pressure, which is increased during certain emotional excitement. Many more illustrations of emotional reactions that were once clearly serviceable may be found. Man has advanced beyond the stage where many of the originally serviceable reactions are of present utility. They are, therefore, not executed as they once were. Modified, or atrophied, they now exist only in weakened and rudimentary form as tendencies to action, and they fail to do more than stir up the organism. In some cases they are antagonistic to later-acquired co-ordinations, and are consequently partially inhibited or suppressed.

While it seems probable that certain emotional reactions can be explained by the principle of utility, there are others which refuse to be accounted for in this way. In what way can the cold sweat, nausea, and dryness of the mouth in fear, the lump in the throat in grief, and the swallowing in embarrassment, together with many other organic excitements, be thought of as derived from once-useful adjustments? James is of the opinion that many of the emotional reactions are "purely mechanical or physiological outpourings through the easiest drainage-channels," and are to be looked upon as accidental or even pathological disturbances rather than once-serviceable reactions. Mosso, who has given the subject much attention, also thinks that many emotional organic disturbances are morbid and useless reactions. He says: "We have seen that the graver the peril becomes, the more do the reactions which are positively harmful to the animal prevail in number and in efficacy. . . . Their extreme degree is indicated by morbid phenomena which show an imperfection in the organism. We might almost say that Nature had not been able to frame a substance which should be excitable enough to compose the brain and spinal marrow, and yet which should not be so excited by exceptional stimulation as to overstep in its reactions those physiological bounds which are useful to the conservation of the creature." [1]

Recent physiological researches have, however, shown that some of these emotional organic disturbances in question do serve the organism in emotional crises. It has been shown, for instance, that when a cat is frightened or angered by the barking of a dog certain glands attached to the kidneys immediately begin to secrete a substance known as adrenalin. The adrenalin is thrown into the blood and causes the blood vessels in the abdominal organs to contract and those in the legs, lungs, heart, and brain to dilate. The blood is thus forced into the muscles which are needed for escape or attack, and the heart, lungs, and brain are prepared for the extraordinary effort needed to adjust the animal to the new situation. The barking of the dog awakens in the cat impulses of attack or flight, which in turn stimulate the action of the adrenal gland. The emotional seizure thus serves a definite purpose. Other emotions may have similar stimulating effects on the different glands of the body by virtue of which the organism is better prepared for needed adjustments.

According to Darwin all emotional reactions, or expressions, are due either (1) to survivals of once-useful acts, or (2) to movements antithetic to those acts, or (3) to move-

[1] "La Paura," Appendice, p. 295.

ments resulting from excess nervous discharge or overflow. The first principle we have discussed. The principle of antithetic movement is stated by Darwin as follows: Certain mental states lead to certain forms of actions which are of service to the organism. When a directly opposite state is induced there is a strong involuntary tendency to the performance of movements of a directly opposite nature, although they are of no use. In some cases these movements are highly expressive.[1] Darwin explains the expressions of the feeling of impotence by this principle. The feeling of power which is present in the emotion of rage leads to the expression of lowered eyebrows, raised shoulders, and clenched fists. Now the feeling of impotence is a mental state directly opposed to the feeling of power. Accordingly, it manifests a tendency to movements of an opposite nature, which are raised eyebrows, lowered shoulders, and open palms. This principle of antithesis has not been very widely accepted by critics. The third principle—that of excess nervous discharge or overflow—we have accepted as the neural condition accompanying the impeded conscious activities which form the psychical basis of emotion.

In emotions, then, we are aware more or less vaguely of a mass of organic reactions and bodily movements. Instead of our having an emotion first and acquiring its so-called expressions later, it turns out that certain useful instinctive reactions acquired in the struggle for existence, and certain movements due simply to excess nervous discharge have left after-effects within us which are conditioning factors in emotional seizures. It is, therefore, not correct to think of these bodily reactions merely as *expressions* of emotions. Their function was not to *express* emotions, but rather to respond in an adaptive way to the situations which start the bodily reactions. To an external observer these reactions may be signs of the presence of certain emotions, but from the point

[1] Taken with verbal changes from "The Expressions of Emotions in Man and Animals."

of view of the person who is experiencing the emotion they are not *expressions.* Whenever we speak of these reactions as expressions of emotions we mean only that they are symptomatic of emotional states.

Among the bodily reactions characteristic of emotion are the facial expressions which seem to form a class by themselves. Thus, we look disappointed, hurt, or pleased; we smile, shed tears, or turn up the nose. These so-called emotional expressions call for consideration because they do not at first glance seem to come under the principle of utility. Of what use to the organism was the reaction of smiling, or shedding tears? Thorndike[1] asserts that they are useful reactions in that they *make a difference in the behavior of other men* toward us. Any woman knows the utility of tears in this respect, and has instinctively made effective use of them from the very beginning. Wundt[2] proposes another explanation. He thinks that the facial expressions of emotions correspond to definite reflex and adaptive adjustments made in response to stimuli affecting the facial sense-organs, especially those of taste and smell. Thus the emotional expressions of the mouth resemble the reflexes set up by the taste-stimuli of sour, bitter, and sweet. When a man looks "sour" or "bitter" in disappointment, or anger, his mouth makes the same movements and assumes the same positions that it does in actually tasting sour and bitter substances. "Sour and bitter looks depend upon reflex movements which serve to prevent the contact of certain ill-tasting substances with the portions of the tongue most sensitive to them." Likewise when the maiden looks sweet and smiling the facial expression is similar to that in actually tasting a sweet substance. Since the tip of the tongue is most sensitive to sweet, the movements consist in drawing back the lips about the tip of the tongue in order to bring it "in as complete contact as possible with the sweet substance."

[1] "Educational Psychology," vol. I, p. 158.

[2] "Human and Animal Psychology," Lecture XXVI.

Now, the taste of sour and bitter and sweet are connected with the affective states of pleasantness and unpleasantness. It seems probable that other cognitive experiences having similar affective states should become associated with these facial senses, especially in the primitive stages of life. Unpleasant experiences of any kind would naturally remind primitive man of these gustatory sensations connected with food-getting, and their arousal would initiate their motor reflexes and so give rise to sour and bitter looks. Likewise pleasant experiences would make him look sweet and smiling. In time the gustatory terms would drop out so that the connection between unpleasant experiences and sour and bitter looks and between pleasant experiences and sweet looks would become a direct one. If this is true it seems necessary to assume a neural connection in the central nervous system between other centres than the gustatory centre and the muscles of facial expression. Observation of the facial contortions of any new-born baby seems to lend support to this hypothesis.

The result is that "analogous feelings" tend to copy or imitate already established responses to stimuli. This principle explains why in moral disgust we raise the nostrils and turn the head away, just as we do when actually experiencing a nauseous odor. We must, of course, allow for a certain amount of variation and modification in these mimetic movements. They may become, as emotional expressions, more or less modified or changed from their original form. It is interesting to note that these borrowed reactions now seem perfectly appropriate to the emotions in which they appear.

The fact that mimetic movements are present in the new-born child raises a question in heredity and evolution. This explanation of emotional facial expressions seems a plausible one for the individual, but if the expressions are original in the new-born child the associative connections formed in primitive experiences must have been fixed in heredity. Since the associations themselves cannot be transmitted from one generation to another, the neural mechanism of the association must be. If the young child, long before he has had any extended experience in gustatory sensations, manifests the emotional facial expressions during his affective states, then he must have inherited the neural connections whereby central stimulation, as well as gustatory stimulation, can occasion the mimetic responses. We cannot go further into this question here because it involves certain fundamental biological problems concerning heredity which have not yet been settled.

**Conditions Which Give Rise to Emotions.**—Since emotions are characterized by the bodily resonance resulting from instinctive impulses which exhaust themselves within the organism itself, our next task will be to find out under just what conditions these bodily affecting reflexes are called into being. Why do certain objects or events excite the bodily affecting impulses instead of the motor co-ordinations which deal directly and efficiently with external objects? We shall find in examining a series of typical emotions that they are initiated by the perception or ideation of objects or events which obstruct our conscious plans and purposes, and inhibit the adaptive voluntary and involuntary co-ordinations which serve to carry them out. Zeno the Stoic said that "emotion is a movement in opposition to the soul." In all emotional seizures there is a sudden interruption of conscious action and a consequent checking of voluntary control because of the presentation of certain stimuli to which the organism does not consciously adjust itself. In all cases of blocked conscious control there are two possible results. Either the nervous excitation, set up in the brain centres by the stimuli, may drain off into co-ordinated and smoothly running instincts and habits which are effective in dealing with the situation, or it may be turned back and diffused into organic and motor channels and there arouse a mass of conflicting organic and motor impulses. It is the latter alternative which furnishes the condition for emotion. We have already noted that in such cases part of the nervous overflow follows old hereditary pathways leading to once useful reflexes. It is also true that part of the nervous excitation may escape into ineffective habitual and voluntary pathways, *i. e.*, ineffective so far as the present stimulus is concerned. The essential condition for emotion, however, is that conflicting motor tendencies are aroused, and that these tendencies are initiated by the appearance of conscious states which suddenly block conscious activity and interrupt the continuity of our plans and purposes. In so far as consciously directed activity or instinctive behavior does not lead to conflicting impulses, but runs out into single and consistent lines of adaptive movements, the condition for emotion is not present. We may see this principle illustrated in any one of the clear-cut emotions. For example, a traveller in the north woods becomes aware that a pack of hungry wolves is close upon his heels. The perception of this fact suddenly breaks in upon his consciousness and intrudes itself as a barrier to the purposes dominating his mind at the time. He sees himself torn to pieces by the hungry beasts, and all his plans frustrated. His mental faculties are paralyzed. He cannot think himself out of the difficulty. The nervous excitement started by the sound of the oncoming pack is discharging into organic and motor pathways. He turns pale, trembles, and feels a sickening sensation in his stomach. His mouth becomes dry and beads of perspiration stand out on his forehead. He is torn by conflicting impulses to cry out, to run, to hide, to stand still, to crouch down, to defend himself, etc. Just as long as our traveller is unable to shut out the disturbing and interrupting conscious states which are initiated by the threatening stimulus, and fails, therefore, to get control of consciousness, he is swept by paroxysms of fear. On the other hand, the moment he is able to think of some way out of his dilemma—if he happens to remember that on the trail just ahead, under a clump of trees, is a log cabin which will furnish a means of escape from danger, the obstructing conscious states are crowded out. The onward flow of his mental processes will be resumed and all his nervous energy will drain off into the single adaptive reaction of running. So long as no doubt of his ability to reach the cabin in time enters his mind there will be no conflicting impulses within and the emotion will die down. In this case, the perception of the wolves is not an obstruction to the conscious purposes which the traveller has in view. The perception of the wolves takes its place in his consciousness without interrupting its progress toward the desired end. The chances are, however, that the traveller will be unable to keep his thoughts fixed upon the single purpose and the movements necessary to carry it out. Each fresh outburst of the howling beasts behind will tend to distract his mind and set up conflicting impulses to look back to see if the pursuing animals are gaining upon him, to stop and defend himself, to hide, or climb a tree. The organic overflow of nervous excitement again takes place and recurrent waves of fear seize him. Not until the antagonism of mental states and the conflict and inhibition of impulses has ceased will he be freed from his terror.[1]

The emotion of joy manifests entirely different sets of antagonistic conscious states and conflicting impulses, but the same conditions of obstructed conscious flow and consequent diffusion of nervous excitation are found here as in other emotions. The telegram announcing the final success of some enterprise for which we have been eagerly striving suddenly puts a barrier across the line of our thoughts. For the moment we are dazed. The mental processes do not go on in the same uninterrupted way. We cannot instantly adjust ourselves to the new situation. We are seized with impulses to jump and dance, to shout, and laugh, to thump or hug the person nearest at hand, or even to cry with tears of joy. Previous thoughts of doubt and failure are revived

[1] See also Angell's description of fear, "Psychology," p. 375.

and overcome by the present knowledge of success. The emotion rises in proportion as we become aware of the tension and stress between the impulses coming from the antagonistic and oscillating thoughts. Not until the mental cyclone has passed do we get possession of our senses and act in a sane and sensible manner. And so we might go through the list of emotions only to find in each case the same condition of conscious interruption and conflict. Some emotions manifest this condition more markedly than others. As it manifests itself less and less the emotions shade off into simple feelings.

The different qualities which emotions show are determined by the nature of the organic and muscular responses aroused by the various emotional objects and events. We have already found that many of these different organic responses are in turn determined by hereditary influences which reach far back in organic development. They are the remnants of adaptive reactions which now play upon the organism and re-echo earlier struggles for existence. But we must not forget that these reactions are set off by the overflow and diffusion of nervous excitement accompanying interrupted or blocked conscious processes.

**Significance of Emotions.**—Emotional seizures appear in situations where new adjustments of consciousness are needed in order to go forward efficiently. They are signs that the organism has need of more than the usual supply of nervous energy to meet the situation presented. The temporary agitation and bodily disturbance may therefore be looked upon as a means of preparing the organism for extraordinary effort. The diffused excitement starts the machinery going along many lines of bodily activities, and thus serves as a kind of general preparation. It may seem at first thought that we shall have difficulty in applying this principle to the depressing effect of an emotion like that of grief. But we must remember that situations which occasion the depressing emotions do not call for vigorous action to meet them properly. On the other hand, they demand quiet and repose before we can become adjusted to them. The emotion in these cases furnishes an outlet for the excitement caused by the disturbing facts. Sorrowful situations are for the most part events that have already taken place, and nothing that we can do will change them. The situation requires then simply a rational and philosophic attitude on our part.

**Classification of the Emotions.**—Since emotions are highly complex mental states into which many different conscious elements may enter, it is to be expected that psychologists will group them in all sorts of ways, accordingly as they emphasize this or that factor. Emotions may be classified upon the basis of their predominant and primary affective states as *pleasant* and *unpleasant* emotions; or according to the intensity of these affective states as *weak* or *strong* emotions; or according to the character of their bodily reactions as *sthenic* or *asthenic* emotions; or according to the form of their occurrence as *slowly arising* or *suddenly arising* emotions; or according to the external situations which occasion them as *food* emotions, *sex* emotions, etc.; as *egoistic* or *non-egoistic* emotions; as *sensuous* or *intellectual* emotions; as *subjective* or *objective* emotions, and many more. Some of these classifications are purely psychological and some psychophysical. Wundt has proposed a very elaborate classification based upon psychological differences only.[1] Bain's classification of the emotions found in the Appendix of his "Emotions and the Will" is worthy of note.

**Emotions and Memory.**—We have already spoken of the fact that feelings are not likely to be recalled, but are created anew when our cognitive experiences are recalled. As we should expect, our emotions, too, are not subject to recall. We can remember that we were angry or sorrowful, but we do not image the emotions themselves. When we think of a past insult the anger which arises is a new anger, not the old anger that we experienced at the time the actual insult was

[1] "Outlines of Psychology," English translation, p. 198, paragraph 13.

received. The more vividly we image the circumstance the more likely we are to experience anger when thinking about it. The thought causes the same impeded consciousness and the same or similar organic diffusion and conflicting motor impulses and the emotion becomes actual, not recalled. Shame and anger are especially liable to be recreated by the memory of the original events which occasioned them. We blush with shame when thinking of some recent folly of ours. We set our teeth in anger when we recall some personal affront.

Time, however, lessens the intensity of these repeated emotions, or even leaves us cold and without emotional warmth. Events, which at first stir our very being when we think of them, come in time to be recalled with no emotion whatever, although the events themselves are remembered as vividly as before. This means that these memories become rationalized and harmonized into our conscious life, so that they cease to be obstructing conscious factors. If this were not so, we should be so beset by disturbing emotions that clear thought and efficient behavior would be impossible. The nervous energy which is at first set free in emotional excitement becomes available, through this process of accommodation, for rational control. This subduing effect of time makes the difference between the hot-headed and impetuous youth and the mature and experienced man of the world.

# CHAPTER XVIII

## CONSCIOUSNESS AND BEHAVIOR

From its very first appearance in the life process, consciousness has been connected with the motor responses. In fact its fundamental function has been to guide behavior. But the individual begins his career with a group of native reactions which are not consciously controlled or directed. These native forms of behavior are the purely physiological reactions, the reflexes, and the instincts. They are present prior to experience on the part of the individual, and although they are not controlled by him they nevertheless serve to adjust him to his first surroundings. These native reactions serve as a foundation upon which the individual builds up his acquired forms of behavior which are necessary for his continued existence.

The native reflexes and instincts represent the individual's hereditary endowment in the way of behavior, while the acquired reactions represent what he gains for himself through the aid of consciousness. After the first stages of development both native and acquired reactions are present. As development proceeds the acquired reactions increase in number and complexity and the native reactions are modified by experience. The behavior of the organism becomes, therefore, a varying mixture of native and acquired reactions —sometimes largely native, sometimes largely acquired reactions, depending upon whether the conscious experience of the organism plays a small or large part in determining its behavior.

So far we have spoken only of the co-ordinated reactions of the organism. Over and above these reactions the organism manifests a group of unco-ordinated and diffuse movements which are usually spoken of as random movements. While these movements are the result of stimulation, they are not directed to any particular end. They are the outcome of diffuse nervous energy flowing into the muscles of the body.

To complete our list of bodily reactions, or behavior, we must add the important group of volitional reactions. Volitional reactions are the acts which are immediately determined and controlled by consciousness.

Summing up the forms of behavior we have:

1. Purely physiological reactions.
2. Unco-ordinated random reactions.
3. Native reflexes.
4. Instincts.
5. Acquired reflexes.
6. Habits.
7. Ideo-motor reactions.
8. Volitional reactions.

The *physiological reactions* are those in which consciousness plays the least part. They are usually considered as unconscious reactions.[1] They are the reactions involved in respiration, circulation, intestinal processes, glandular secretions, pupilary reflexes, etc.

The *unco-ordinated random reactions* are the diffuse movements which have no definite end. A brightly colored object may stimulate the young infant to make many random movements in the different parts of the body. Head, face, arms, legs, and feet may all move about in an aimless way when he catches sight of the object. Since the child has inherited no definite, preformed neural pathway for carrying off all

[1] The purely physiological reactions are not absolutely divorced from consciousness. It is a demonstrated fact that mental states may influence or even initiate these physiological activities. The perception of food may start the secretion of saliva. The presence in the mind of certain ideas may affect circulation and respiration—the bated breath, the blush of shame, the pallor of fear, the flush of anger, all testify to the effect of consciousness upon the purely physiological activities.

nervous excitement, it is diffused into various pathways leading to a large number of muscles. This diffused activity has been called "excess reaction" or "multiple response to a single stimulus."

The *native reflexes* are the simplest and most direct coordinated movements. They are made in response to sensory stimuli. The closing of the baby's hand when the palm is stimulated and the sucking movements following tactual stimulation of his lips are common illustrations of the native reflexes.

The *instincts* are complex native reactions composed of a number of native reflexes chained together in such a way that they lead to an adjustment of the organism as a whole to some outer situation. Sometimes the term instinct is used to signify all the native reactions from the purely physiological reactions to the most complex native reactions. We shall use the term to signify only the complex chained reactions leading to a single end. Instincts are inherited forms of reaction and are, therefore, the result of the transmission from parent to offspring of preformed neural pathways. While instinct is not consciously controlled by the individual, it is nevertheless attended by an impelling consciousness, craving or appetent in quality. Illustrations of instincts are found in the reactions of fear, anger, jealousy, rivalry, acquisitiveness, parental love, play, and imitation. In man instincts are rarely pure, for they are modified by experience and supplemented by volitional and acquired activities.

The following reactions are all acquired, and differ from the preceding forms of motor activity in that they are learned during the lifetime of the individual as the result of his own experience.

The *acquired reflex* is the simplest acquired response. Acquired reflexes are the elementary reactions out of which habits are formed. These reflexes are direct responses to sensory stimulation. Illustrations of acquired reflexes are found in the simple movements of skill which when chained together constitute ability in playing tennis, performance on the piano, etc.

*Habit* bears very much the same relation to acquired reflexes that instinct bears to the simple native reflexes. Habit is a complex act composed of a number of simple reflexes chained together and so co-ordinated that they result in movements toward a definite end. Habit is like instinct in that it is a relatively fixed form of reaction, depending upon the existence of neural pathways and going on without the control of consciousness. It is unlike instinct in that it is a form of behavior which has been learned by the individual, acquired by virtue of his own experience. It is individual rather than racial in its origin. Movements which are often repeated under conscious direction become habits. The piano-player at first must consciously direct each single movement of his fingers, but after many repetitions the movements become so closely associated together that they may go on without conscious control. According to the "law of habit" motor reactions once made make it easier for the same reactions to occur again. This is due to some form of neural modification left in the nerve pathways of the brain by past experience. The nervous material is sufficiently plastic to be modified by repeated neural activity, and yet sufficiently stable to retain the modifications.

Habit involves the perception, or image, or thought of some object or situation which has in the past been associated with the motor activities making up the habit and, in addition, the consciousness of the sensations arising from the simple movements as they take place. Each sensation is the cue for the next movement, which in turn gives another sensation, serving in its turn as the cue to another movement, and so on until the series of movements and sensations are run off. This sensory-motor process takes place within some conscious purpose or plan. The plan or purpose does not, however, include the conscious control of the single movements. The part which kinæsthetic sensations play in habit is made evident by the fact that if they are absent habit is seriously interfered with. For instance, in locomotor ataxia the patient is, by reason of a diseased condition of the spinal cord, insensible to the sensations of movement in the lower extremities. For this reason locomotion becomes very imperfect and in some cases impossible. By means of certain drugs sensations of movement in the hand and arm may be lessened or abolished for a time. This temporary anæsthesia makes it extremely difficult for the hands to perform any of their accustomed acts or habits.

*Ideo-motor reactions* differ from the reflexes in being a response to an image or thought instead of a response to a sense presentation. The image of an act or of the result of an act may be followed immediately by the act which takes place without conscious intention. The act is then said to be ideo-motor.

**Volitional Action.**—The discussion of volitional action should have introduced the description of all the acquired reactions—acquired reflexes, ideo-motor activities, and habit. For these are best understood in the light of volitional activities. Most of our acquired reactions were originally volitional reactions. Before they became fixed as habitual forms of action they required the constant control of consciousness. Volitional action is therefore a transitional stage of activity. It is really not acquired action, but action in the stage of being acquired. From the point of view of consciousness it is the standard form of activity. All acquired forms drop away from it as they require less and less consciousness in their control. Volitional reaction always involves full consciousness of the action. We know exactly what we are going to do before we act, and what we are doing while the act is going on. Every act is imaged before it is performed and consciously followed during its performance. In addition volitional activities involve the consciousness of the end or consequence of the act.

Still another factor must be considered in volitional activity,[1] and that is the consciousness of some purpose which is accepted or consented to, and within which the image of the act and its immediate consequence lie. This is what is meant when we say that we act with intention. The intention or purpose may include in its simplest form only the immediate consequences of the act, or it may include the far-reaching consequences of some life plan. For instance, I may pick up the pen from my desk simply because I consciously desire to see if it is broken, or because I wish to write my will. However, in a fully conscious or volitional act, purpose or intention must be present. The consciousness which presides over volitional activities is impulsive, as in all motor consciousness. But it differs from the vague, impulsive consciousness accompanying instinct or habit in possessing full awareness of the end, awareness of the movements necessary to accomplish the end, and the conscious approval of the end. The impulse may be described as the expectant attitude toward or the anticipation of some definite end represented as following certain movements. The idea of the movements unblocks the outgoing motor pathways leading to the muscles involved in the act. Just how this unblocking of motor pathways in the brain is accomplished by consciousness we do not know. We do know that thought of a movement tends to be followed by the movement, and that the thought of an end tends to be followed by the movements necessary to bring about the end. We shall discuss this fact more thoroughly later.

Our analysis has laid bare three factors in volitional action:

1. Consciousness of the act to be performed.
2. Consciousness of the end or consequences of the act.
3. Consciousness of an accepted purpose or intention.

[1] Volitional activity is usually thought of as including any form of activity following conscious intention or purpose, whether the activity itself is immediately controlled or not. In this sense habitual activities may be termed volitional activities. But volitional activity as used here is limited to those activities requiring constant conscious control.

Consciousness of the act and of its end is present in the form of images just before the act is executed. These images may be: (1) *Resident images*, consisting of the mental images of the sensations of movement (kinæsthetic images) needed in the act, and (2) *remote images*, consisting of the mental image of the result of the act or the end as accomplished. For instance, if I image the sensations in the throat and lips which occur in the pronunciation of the word "piper," we term the image *resident*. If, on the other hand, I image the effect of the act (in this case the word as it would sound when it falls upon the ear), we term the image *remote*.

Now it is true, as some psychologists contend, that acts may in our every-day life follow upon either form of imagery or, in fact, may follow any mental state whatever, provided the act has been in the past associated with it. The mere sight of the word "piper" on a printed page may be followed directly by the act of its pronunciation without any imagery interposed between the perception and the act. The thought of musical instruments, the image or perception of a rat, the thought of children, or the sound of the word Hamelin may be followed immediately by the pronunciation of the word "piper." But in any one of these cases the response is not a "fully conscious" or "volitional" activity. It is rather a form of acquired activity which goes on without conscious direction—a conscious reflex or a simple habit—depending upon past associations.

A volitional act may be, and usually is, a new act—a new adjustment—or a new combination of old acts. Now a new act must be consciously imaged and consciously intended before it can be performed. It has no past, and consequently there are no associations or tendencies established which will call it into being. As volitional action is repeated again and again, the controlling consciousness which was present in the beginning drops out—first the resident, then the remote imagery, and even the intention or purpose, until any conscious state which has been associated with the act is sufficient to initiate it. It then becomes an acquired activity. This means that in many cases the first stages in the formation of acquired reactions are volitional. When consciousness is able to take note of the native reactions, and can image the sensations involved in them, it has adequate material for volitional activity. Volitional activity, then, lies between the native forms of behavior and the acquired forms—between what the organism already has and what it is going to have. In this transformation consciousness plays the chief rôle.

In order to avoid a possible confusion we should note the fact that we may exert a volitional control over activities which are in themselves not volitional. For instance, volitional control makes use of acquired reflexes and habits. Evidently we must make a distinction between volitional in the larger sense and volitional activity in the stricter sense. I may will to write a letter and post it before noon to-day, but the actual writing and posting activities are all well-formed habits and may need little conscious control, and are, therefore, in themselves not volitional acts. Even in the stricter sense, volitional activities may include well-formed habits within the total activity. While consciousness is busy controlling the newer parts of the activity-complex, the habits within it run themselves off subconsciously. Much of human behavior is mixed, partly new and consciously controlled and partly old, and, therefore, needing no control. The higher and newer forms of behavior are constantly incorporating and making use of the lower and familiar forms.

While this, briefly, is the history of the formation of many of our acquired reactions, it is not the only way that they are developed.[1] So far we have considered only those reactions which can be consciously represented before they are executed, and consequently we have noted only those acquired reactions which come to be what they are through direct conscious control. This conscious control of movement is the highest and most direct method of learning new activi-

[1] Hobhouse: "Mind in Evolution," chap. VIII.

ties. It is probably not present in the lower animals, for it is possible only where conscious representation of past movements and their results exists. While man takes advantage of this higher type of learning, he exhibits in common with the animals a lower and more primitive method of building up his acquired adaptive responses[1]—the method of "trial-and-error" or the "hit-and-miss" type of learning.

As an illustration of the "trial-and-error" method we may describe briefly one of Thorndike's experiments with cats. He prepared a box whose cover and front side had been replaced by bars an inch apart. A door was placed in the front, and so arranged that it would open when a wooden button inside was turned from a vertical to a horizontal position. A very hungry cat was placed inside and a bit of fish just outside. The stimulus offered by the odor of the fish excited the cat to make many random reflex and instinctive movements. It ran about clawing and biting at the bars until, after a long time, one of the random movements happened to turn the button, the door fell open, and the cat obtained the fish. When the experience had been repeated again and again on succeeding days the cat came gradually to omit all the random movements but those of clawing and biting the button. After many trials it learned, therefore, to open the box immediately by pushing the button with its claws or nose.[2] In short, it had acquired a co-ordinated reaction on the basis of its native activity. There was at first a mass of diffused random and instinctive movements called out by the stimulus. Then followed the gradual elimination of useless and unsuccessful movements, and the selection of the movements necessary to meet the situation. There was no conscious representation of past experience, and consequently no conscious control or volitional activity. The first successful movement was a chance reaction present in the many diffused reactions. The final acquirement of the re-

[1] Ruger: "Archives of Psychology," June, 1910.
[2] Thorndike: "Animal Intelligence."

sponse came only after many repetitions of the same experiences. Of all the movements which the cat made, the movement of pushing the button was the only one which was followed by a definite result giving satisfaction. The movement thus gradually became associated with the box, button, and fish situation. It was subsequently always called out by that situation. If, however, in such cases some element in the situation is changed, say a sliding bolt is exchanged for the button, the animal finds itself helpless, and must go again through the long process of "trial and error" in order to adjust itself to the new condition. The part which consciousness plays in this process is not as clear as in the case of volitional activity. The feelings of discomfort before the proper adjustment happens to be hit upon, and the feeling of satisfaction when it is found, form a conscious background for the right movements and serve to emphasize and differentiate them. Here we must assume a native tendency in the organism to avoid reactions which bring discomfort and seek those which bring satisfaction.

Young children manifest very markedly this type of learning new adaptive responses. Any novel stimulus will call out a mass of diffused activity containing some movements more or less adaptive. The selection of the right movement goes on in much the same way as in the case of animal learning. The selection may be characterized as the "survival of the fittest responses."[1] In adults the method of "trial and error" is especially evident in acquiring acts of skill. It is present in the first reactions to especially novel situations. But, after the first successful response, conscious representation and control appears and shortens the process. In the acquisition of skilled movements, however, it often happens that the finer adjustments are incapable of being analyzed out of the total activity. The kinæsthetic sensations which these movements arouse are too indistinct to be differentiated from each other, and so they form a general mass of sensa-

[1] Dexter, *Educational Review*, vol. XXXIII, p. 81.

tions. In this case the movements cannot be imaged, and therefore cannot be consciously controlled. The only method by which they can be acquired, then, is that of the "hit-and-miss" type—try-try-again method. Continuous and patient practice will give variations in the nature of the movements. Some of the movements will fail, and some of them will just hit the mark and will be accompanied by the feeling of satisfaction. Gradually and slowly these latter movements are "stamped in" and all others eliminated until the skilled act is acquired. The finer adjustments necessary in playing tennis, billiards, golf, etc., the skilled touch on the piano or violin, and the exact tension of the vocal chords in singing, must all be acquired slowly by the hit-and-miss method of learning. This is so because we are unable to analyze out, and consciously represent, the extremely fine adjustments necessary for these activities. In just so far, however, as we are able to sense the fine differences in the kinæsthetic sensations of skilled movements, and are, therefore, able to represent mentally the movements, we can consciously control them; but when the differences are too fine to be sensed we are forced to rely on the more primitive method of learning.

Comparing these two types of learning new adaptive responses, we find that the chief difference between them lies in the method employed in selecting the responses that are to become fixed as the future equipment of the organism. The stages of development are as follows:

| *Learning through trial and error:* | *Learning through conscious representation:* |
|---|---|
| 1. Native reactions. | Native reactions. |
| 2. Gradual acquirement of successful reaction. | Volitional reaction. |
| 3. Acquired reaction. | Acquired reaction. |

In the method of trial and error the second stage appears to be a form of natural selection in which the units of selection are single reactions within the organism instead of individual organisms, as in natural selection proper. The diffused random actions furnish variations from which selection of the fit reaction is made. According to the theory of natural selection, however, no account is taken of the positive agency of consciousness in determining what organisms are to be selected. The unfit are damped out by the environment; the fit survive. On the other hand, in learning new responses, even by the trial-and-error method, the organism is undoubtedly aided by consciousness. There is a general conscious tendency toward some end. This tendency drives the organism to further endeavor. The feelings of pleasure accompanying success and of displeasure attendant upon failure serve, as we have already indicated, to stamp in the successful reaction.

In the higher type of learning new responses (learning through conscious representation), the method of selection makes use of direct conscious representation of modes of past activity. Images of previous movements are raised to the level of reflective consciousness and made to serve as a controlling agency. The new response then takes place under conscious control until it becomes fixed. Then consciousness tends to disappear.

It is evident that consciousness is a factor in learning new responses. It is not needed in either the native or acquired reactions. There adjustments take place with automatic regularity. But where the native and the acquired adjustments are inadequate, there is need of a directive agency. In such cases the best endeavor of the organism is challenged and it responds with the highest power it possesses, that of consciousness. Such occasions furnish the opportunity for the most rapid conscious development. In fact, without these crises in the life of the organism no progress is possible. Unless new responses are constantly in process of acquirement, education ceases. So the greater the number of adjustments required in the life of an organism, the higher the stage of development it will reach. The organism that is perfectly adjusted, *i. e.*, has all the native and acquired responses needed to meet its requirements, has reached the end of its conscious development. Perfectly formed habits, while they are useful in maintaining life on the level of its present attainment, do not serve to raise the organism to a higher level. It is only in the formation of habit that the process of education goes on. Practically no advance comes from the habitual modes of activities. Man's high development is due to the fact that he is continually forced to learn new habits of action in order to adjust himself to the world about him. He never becomes fully adjusted because, as he develops, his environment enlarges and changes, and consequently demands new responses. This requires the formation of a large number of habits which must be continually broken up and reformed under the direction of consciousness. It is where his habits become absolutely fixed that he ceases to develop. For this reason long-continued operation of an automatic machine reacts deleteriously upon its operator. The man who works eight hours a day, month after month, upon such a machine is limited in his activities to a monotonous circle of habit which inhibits mental activity, and in the end lessens the plasticity of the nervous tissue, and therefore the possibility of reactions of a higher order. He thus finds himself caught in the net of habit. The deadening effect of automatic work upon the worker is greatest where the reactions are most habitual, and where the activities required are simplest and least varied in their nature. On the other hand, where the work of the day is varied—where the worker is called upon to make a large number of new and varied adjustments—there his mental life is constantly being stimulated and his activity is educative. As we have already said, education lies in the process of forming new habits of behavior through conscious control, and development ceases when these forms of behavior become fixed.

In the primitive method of learning through the trial-and-error method, the random motor activities always take the direction of simplification and fixity with a decreasing accompaniment of consciousness. But in the higher method of learning new responses through conscious representations, the volitional activities may take two directions: (1) Toward simplification, regularity, and fixity (habits), with decreasing consciousness and loss of plasticity; or (2) toward complexity and variability, with increasing consciousness and mental development. In the latter case, volitional activity is constantly enlarging its field of action and involving the mental processes of memory, imagination, deliberation, comparison, and judgment.[1]

**Genesis of Motor Activity.**—So far we have confined our attention to the motor activity as we find it going on in the individual organisms. We have seen that each individual inherits a stock of native reactions, out of which he builds his future behavior through the aid of consciousness. If we inquire into the source of these native reactions we must pass from individual to racial development. How did these organic reactions get formed in the first place? Were they originally conscious reactions from which consciousness has lapsed, or were they formed without the aid of consciousness? In other words, was consciousness present from the beginning of organic activity, or did it appear after the original forms of activity were in operation in the living organism? The problem is partly biological and partly psychological, but in neither science is there a sufficient basis of facts to solve it. Authorities differ in their theories: Some hold that consciousness was present at the beginning of organic life, and that the first movements of the first organisms were conscious movements. Later, when the movements became fixed, consciousness lapsed, and the forms of activity were then passed on to later generations by heredity. The instincts, for instance, are thought to be originally consciously controlled activities, which through repetition became so thoroughly ingrained in the organisms that they no

[1] James: "Principles of Psychology," chapter on "Habit."

longer needed conscious direction. This theory of the origin of instincts is known as the "lapsed intelligence theory." The following facts are urged as evidence in support of the theory:

1. Habits which are formed under the direction of consciousness may later become sufficiently automatic to take place without the aid of consciousness. Instincts may have been primitive habits which are preserved by heredity.

2. Many of the purely physiological reflexes and instincts can now be modified by conscious direction. This fact suggests an original conscious control.

3. Certain emotional reflexes, like raising the nostrils in contempt, are analogous to the primitive uncovering of the teeth in our semihuman progenitors when they were about to attack an enemy. The emotional reflexes may, therefore, be survivals of earlier conscious action.[1]

Other authorities believe that consciousness appeared in racial development after the physiological reflexes were in operation, and that the first movements were, therefore, unconscious reflexes. The Spencer-Bain theory of the origin of consciousness holds that life was at first without consciousness. Consciousness appeared at a moment of neural stress in some unusually heightened or lowered nervous process—probably in both. Instincts, then, are the accumulation of unconscious adaptive reflexes preserved and chained together by natural selection. This is known as the "reflex theory of instincts." Consciousness was at first vague and indefinite—mere feelings of pleasure and pain—and only gradually became aware of the motor activities going on in the organism. Later it developed to the point where it could image and control certain of the reflexes. This marks the beginning of voluntary control.

[1] Wundt: "Physiol. Psychol.," III, p. 279; "Outlines of Psych.," p. 213. Ward: Art. "Psychology," in Encycl. Brit., XX. Cope: "Origin of the Fittest." Titchener: "Textbook of Psychology," p. 452. Baldwin: "Mental Development," p. 208.

The main objection to the first theory is that it seems to demand too high a state of intelligence in the first primitive organisms. Even if consciousness were present in the first organic movements, it seems impossible that conscious representation necessary for the control of movement could be present. The most that could be reasonably granted is a vague organic feeling which is inadequate as a directive agency. Certainly the very first movement of the first organism had no conscious experience back of it which could serve as a guide for its response.

The second theory fails to make clear how a series of simple reflexes were chained together when only the last reflex in the series brought about any gain for the organism. Again it is not clear how an organism which has been reacting without consciousness suddenly acquires it merely on the crest of the wave of heightened neural activity.

Whatever the truth may be about the first reactions in racial development, the first reactions of the organism are not now consciously controlled. For some time the child is only vaguely aware of the native responses which are expressing themselves without his direction. It is not until they have been going on for some time that he is able to take affairs into his own hands and control his behavior.

## The Connection Between Conscious States and Action —The Law of Dynamogenesis

All forms of motor activity above the physiological reflexes involve consciousness. The nature of the consciousness involved varies from mere suggestion to action to volitional control of behavior. In the native and acquired activities consciousness serves in the capacity of suggestion. In volitional activity consciousness controls as well as suggests activity. The most complete connection between consciousness and motor activity is found in volitional activity. So far as we are able to observe, nothing stands between the conscious representation of the act on the one hand, and the execution of the act on the other. When the act or its consequences are imaged and the consent is given, the opening of the motor pathways in the brain seems to be completed and the act invariably follows. There is an immediate connection between consciousness and action. Some of the connections are native and some are acquired. We are born with definite tendencies to act in certain ways when certain conscious experiences come to us, and we acquire through experience definite tendencies to act in response to certain other conscious experiences. We may say, then, that every conscious state tends to express itself in some form of motor activity. This principle is known as the *law of dynamogenesis.*

Any vivid image of movement always involves a motor impulse which tends to bring about the movement imaged. Imagine how it feels to bend the right forefinger and note the impulse to move it. In some cases the actual movement will take place without any definite intention to move the finger. But the image of movement is not always necessary. A large part of our activity is composed of movements following all kinds of conscious states. Seeing my pen on the floor, I pick it up without consciously imaging the movement. If I suddenly remember that I have an engagement, I start for my hat and coat without thinking about what I am doing. Nearly every one has had the experience of performing some act unintentionally which had been thought of some moments before, but which had in the meantime dropped out of consciousness. The motor pathway was unblocked by the earlier thought, and the act appeared at the first opportunity. Just this morning I sat down at my desk with the intention of putting away some letters which I had in my hand. Happening to remember an engagement which I had made, I took out my watch just as I sat down and noted the time, then opened the drawer of the desk and placed the watch where I had intended to put the letters. It often happens that in conversation we use some word or phrase just after determining not to use it for fear of offending a friend. The thought opens up the motor pathway, and if the conscious inhibition lapses for an instant the expression will take place, and when we come to, we realize that we have said just the thing that a moment before we determined not to say. In skilled movements there is oftentimes a strong tendency to repeat an error again and again immediately after its first appearance, simply because consciousness of the first error is still present in the mind. This consciousness acts as a predisposition to the movement. And so we could multiply indefinitely illustrations of the fact that mental states of all kinds make immediate connections with motor activity.

This generalization may appear too sweeping. The implication that every idea which appears in consciousness is followed by a fully executed bodily reaction is, of course, not true. Evidently we have many thoughts which do not find expression in behavior. However, we have reason to believe that the tendency to movement is present in every mental state, even though the actual movement does not take place. The reason for its failure to appear rests in the fact that it is inhibited by the dynamic character of other mental states which rise in the mind at the same time. In the lower animals mental states find immediate expression in motor activity. In the more complex mental life of man the direct expression of consciousness is often modified or inhibited. In the very young child, as in animals, mental states find immediate expression in motor activity. But gradually, as the simplicity of mental life develops into greater manifoldness and complexity, there arises the possibility of conflict between the impulses of consciousness. For instance, a young child with limited experience will grasp the bright flame of a candle if it is placed within his reach, but after he has experienced the painful quality of fire the grasping movement is inhibited. The impulse to reach for the flame is inhibited by the thought of "burnt hand."

The more complex the mental state the fewer are the chances for direct connection with motor activity. But when ideas are clear and definite, and no opposing ideas arise, they lead to action. Men of action are men with single and clear ideas.

The connection between mental states and bodily activities is such that the character of consciousness comes in time to stamp itself upon the physical appearance of the individual. The outer man reveals the inner man so faithfully that we need not wonder at the revelations of the so-called "mind-readers"—most of them persons who have learned the art of reading the character of thoughts by means of physical appearances and actions.

If we consider for a moment the law of dynamogenesis in the light of the history of the development of motor activity, we shall be able to get a still clearer view of the dynamic character of consciousness. In the beginning every stimulus is transferred immediately into action. Through the process of evolution a simple nervous system is developed and set aside for the purpose of taking over the function of transmitting stimulation from one part of the body to another. Then the brain is built up as a receiving and distributing centre for nerve impulses. Now the brain retains the primitive irritability of tissue in that the nerve impulses which reach it from sense-organs are communicated to the organs of response —the muscles. The tendency to communicate stimulation is the same as in the primitive state, but the pathways by which transmission takes place are greater in number and complexity. Meantime consciousness has definitely appeared in connection with the activity of the brain centres. Sensations and perceptions now aid in setting up immediate responses to stimuli through the reflexes and instincts. Later, conscious representation, comparison, and judgment appear and make possible the process of volitional activity by means of which nervous impulses may be directed in definite directions, or even inhibited. While consciousness has become a definite factor in the psychophysical activity, the primitive nature of nerve impulses has not been changed.

There is the same tendency for every sensory stimulation to pass directly into action. Not only sensory stimulation, but thoughts and ideas corresponding to higher-centre activities show the same primitive dynamic character.

**Control.**—Just as in the beginning simple conscious states were connected directly with organic responses and so served to control behavior, so now in its highest forms consciousness is still directly connected with motor activity. The rise of higher forms of consciousness has not changed the nature of control; it has only made it more complex. Rational control comes from the presence in the mind of systems of ideas which check and countercheck each other in such a way that the resultant forces run out into the particular kind of behavior appropriate to the situation which has aroused the ideas. The control of our motor activities lies in the ideas which we allow to take possession of us. He who would follow a single plan of behavior must allow no ideas but those in keeping with the plan to get possession of him. If he does he will find that they will be real forces, tugging at the sinews of his action until in the end they will master him and force him to fight for them.

**Effect of Motor Activity upon Consciousness.**—It was asserted in the beginning of the chapter that consciousness both determines behavior and in turn is determined by it. We may now briefly consider the second part of this principle. The sensations of movements play no small part in the content of consciousness. Every movement of the voluntary muscles gives rise to kinæsthetic sensations which help to determine the character of consciousness. The simple experience of smell is partly determined by the sensations of movement. If we carefully note the differences between movements (in nostrils, pharynx, head, respiratory actions) made when we are smelling some displeasing odor like that of asafœtida, and the movements made when we are smelling the odor of violets, we can easily detect the part which sensations of movement play in the experience. Sensations coming from the movements of turning the head away, stuffy sensation in pharynx from closing the back air-passages and inhibiting respiration, are present in the one case and absent in the other. The content of consciousness in making definite decisions of denial plainly contains the sensations of a peculiar muscular set and tension. The experiences of scorn, defiance, anger, and vast spatial dimension, contain very markedly characteristic groups of muscular sensations. Images of the words we use are usually in terms of the sensations of movements made in speech. Part of the feeling of self consists in the sensations of motor reactions which are going on in our muscles. These sensations contribute a large share in determining our passing moods and emotions.

In the growth and the development of consciousness, differentiation of motor responses is an important factor in breaking up and organizing vague states of consciousness into definite experiences. It is the child's motor reactions toward objects which make them definite things for him and set them off from other objects. His different ways of reacting to objects analyzes the as yet undifferentiable world into elements of experience. He comes to know as one thing that to which he reacts with a single characteristic response. His notion of "chair" is determined by the fact that he sits upon it. His notion of "knife" is determined by the reactions of whittling; of "ball" by rolling, throwing, and catching. Each object in his at first rather hazy world stands out the more clearly and distinctly as his reactions to it become more and more definite. The development and organization of the child's knowledge of the world proceed as he co-ordinates and controls his motor responses. In later development, even in the more abstract processes of thinking, clearness and orderliness of thought are the result of the formation of clear-cut and definite modes of action.

Now, while the sensations of movement stimulate consciousness, and contribute to its content and to its differentiation and development, there is another, more fundamental aspect to consider. This aspect is revealed in the fact that motor activity involves open and active brain pathways. The motor centres in the brain form a drainage area for the higher associational centres, and so provide for and invite greater activity in these centres. We often find ourselves in some situation where we are unable to collect our thoughts. Consciousness is at a standstill, and we remain empty-headed and inactive. Now if we start to say or do something, no matter what, just so we start the neural mechanism going, our wits come back to us and we gain control of the situation. The action opens up the neural pathways in the brain. Anything that tends to block up these outlets of motor activity tends to decrease the chances for the rise of consciousness. The greater the opportunity for response, provided we take advantage of it, the higher the degree of mental development.

## CHAPTER XIX

## WILL

**Conation.**—We have seen that consciousness is impulsive, *i. e.*, leads to motor reactions. This dynamic aspect of consciousness is known as *conation*. Conation manifests itself in impulses and tendencies to action. The broadest use of the term conation has been made to include such philosophical concepts as that of the "will to live," supposed to be a more or less blind innate tendency within us, by virtue of which we are impelled to life-preserving activities. The so-called "unconscious will" is also to be classed among these metaphysical conceptions of the fundamental conative aspects of consciousness. Such conceptions carry with them the implications that some cosmic purpose is constantly striving to realize itself through the conative tendencies. In psychology, however, conation is used in a narrower sense, indicating merely that consciousness is dynamic. Every state of consciousness tends to culminate in motor activity. This motor activity manifests itself in reflexes, instincts, ideo-motor movements, habits, and volitional reactions. Some of these forms of reaction are inherited and some are acquired through individual experience. Most of the reflexes and all of the instincts are inherited, while the ideo-motor activities and habits are acquired. These movements follow immediately upon the appearance of certain mental states. Thus the perception of a hot object is followed by the withdrawing reflex; the presence of the young is followed by the parental reactions; the sight of the door-knob is followed by the movements of opening the door; the sight of the keyboard of the piano and the music score is followed by the complex series of finger co-ordinations necessary to produce the music. The reflexes, instincts, and habitual reactions are relatively fixed and invariable in character, while the volitional reactions are highly variable.

We have noted that the acquired reactions have been built up in two ways: First, by means of the method of trial and error, in which the proper reaction comes out of a mass of random reflex and instinctive movements, and, second, by means of volitional control. Volitional action is a form of conation which we must examine more thoroughly than we have heretofore. In volitional movement we deliberately plan and purposely execute certain acts. All psychologists agree that these movements are, so far as they are themselves concerned, movements or combinations of movements, which the organism has already made, either in an instinctive or reflex way. Volitional activity then consists in the control of movements of which the organism is already capable.

**Will.**—Is volitional activity marked off from the other forms of activities by a new kind of conscious element, distinct from sensation and affection or any of their compounds? Does the control of volitional movements arise from a pure *will element* which does not appear in the non-volitional reactions? So far introspection has failed to reveal any new and special content of consciousness which appears in the volitional activities and which can be looked upon as the will. Where observation has failed to give us facts, theory has attempted to supplement our knowledge. There are many theories about the will. Some of them, the spiritualistic theories, consider the will as a manifestation of the transcendental ego which may act independently of the laws governing the empirical self. Some of them, the empirical theories, consider the will as the sum of the conscious impulses or directive tendencies found in the conscious states themselves. If we were to review the history of psychological thought, we should find that the will has been variously considered. At times it has been identified with the intellectual functions, again with the feelings and emotions, and still again it has been considered as an absolute and independent function of the mind. Accordingly, the conception of the will has varied from the intellectualistic point of view, in which the will is derived from the cognitive processes, to the voluntaristic point of view, in which it is the central point of all consciousness and the basis of all mental life. It has been looked upon both as a form of feeling and as a combination of feeling and idea. The materialistic point of view has considered the will simply as a combination of reflexes grown up in the course of evolution. According to this theory the will is developed out of the automatic reflexes which combine into more and more complex forms, while at the same time consciousness is developing to the point where it can take note of these movements and form kinæsthetic images of them. A clear-cut kinæsthetic image of a movement becomes the mental side of willing. Whenever, according to a modern form of the reflex theory, we image a movement clearly and vividly and hold it in mind before the movement takes place, we then feel that the act takes place by our own volition.

The old tripartite division of the mind into knowing, feeling, and willing was based upon the "absolute theory of the will," which regarded it as an independent and co-ordinate elementary function along with cognition and affection. The tendency of modern psychology is to leave to metaphysics speculation about the ultimate nature of the will, and to confine itself to the study of specific volitional reactions for the purpose of determining empirically the nature of these reactions.

We have already remarked in our discussion of "consciousness and action" that as far as we can observe, nothing in the nature of a unique will element stands between the consciousness immediately preceding a volitional act and the movement which executes it. We found that on the mental side there is either the image of the movement to be made (resident image) or the image of some result of the movement (remote image), and the consent or intention that the movement be carried out. James says that an anticipatory idea of the movement's sensible effect (resident or remote) and the fiat is all that introspection can discover as the conscious forerunner of a volitional act. By the fiat he means holding the idea before the mind to the exclusion of other antagonistic ideas. The prevalence of the idea in the mind terminates the willing and the act takes place mechanically. Only when ideas of competing or antagonistic acts arise does the will manifest itself. Then the strain of the attention to hold one of the ideas before the mind is, according to James, the fundamental act of the will. The will is therefore a psychic act —to fill the mind with the idea, to keep affirming and adopting a thought which if left to itself would slip away—that is the inward volitional act, says James. Accordingly, volition presupposes deliberation in which different alternatives are presented to the mind. These rival lines of action alternate in consciousness—first one and then the other is attended to —until attention finally fixes upon one to the exclusion of all others. The decision or choice is the holding of the given idea of action fast in the mind. When this is done we consent to the reality of the idea.

Many psychologists believe that the control of movements is primarily brought about through the effect of the kinæsthetic images (resident images) of the movements. The image of the movement in some way unblocks the neural pathways leading to the proper muscles and the nervous energy drains into them and brings about the movement. Recent investigations of the control of movement indicate that more prominence should be given to the sensations awakened by the movement itself as a factor of control in the following stages of the movement. The control of a movement requires awareness of the position of the parts of the body moved before the movement begins. This means that each moment of kinæsthetic sensory experience becomes the cue for the following movements. This becomes very evident if we note the contents of consciousness during the act of throwing at a mark or in jumping. Here the control is brought about more by present sensations than by images of past movements or by images of previous results of similar movements. Moreover, not only the sensations of moving muscles, but the more remote visual sensations coming from the target, the height from which we are to jump, and other characteristics of our surroundings, are important factors in the control of movements. As we have previously indicated, pathological conditions in which the sensory nerves from the muscles are so affected that the patient cannot sense the movements or positions of the parts of the body, result in the inability to control movements, although the motor nerves running to the muscles from the brain are intact. Lack of sensations of movement means lack of control of movements. Such a condition is found in cases of locomotor ataxia.

Neither the anticipatory image of an act (resident image) nor the image of the result or consequence of the act (remote image) nor the kinæsthetic sensations of the movements constituting the act give us a new form of consciousness which we can call a will element. If there is such a thing as a pure will element in consciousness it has been playing hide-and-seek with us. A few paragraphs back we said there were certain exceptions to the statement that in careful experimental work on the will introspection had failed to detect any special will element in volitional activities. Ach and Michotte claim that they are able to detect a will element which is present in all volitional activities. They report that they find what they call an actual moment in which there is a content which can be described only by the phrase "I will actually." They claim that this conscious content is that of a subjectively determined act—a pure will act. This is found only in volitional acts and differentiates them from all other forms of action. In this "actual moment" the "I" is taken as the cause of the reaction, and therefore we are conscious of an egoistic control, or self-determined act. It is rather difficult to determine just how far the metaphysical conception of the self or subject of consciousness has influenced the introspection in these cases. There is no questioning the fact that in volitional acts we feel that we are originating and determining the movements. James refers to this experience as an illusion, and Münsterberg considers it merely the anticipatory consciousness of the act. Other psychologists who hold that consciousness is a real agency operating between the reception of stimuli and the motor response, and therefore effective in determining behavior, believe that the will element is to be found in certain directive tendencies of consciousness which they claim transcends the limits of a mere assemblage of elements. The "imageless-thought psychologists," some of them at least, are inclined to believe that the control of volitional movements may be brought about by a pure thought element which is a directive conscious tendency over and above the conscious contents of sensations and anticipatory images of the movements. Ogden, for instance, in his "Introduction to General Psychology," has outlined an interaction theory of mind which admits a purposive activity in consciousness. This active principle works independently of the laws of association and is, therefore, a new determining factor in consciousness. Thus we have a basis for the will. He recognizes three modes of directive tendencies: First, physiological impulses found in the reflexes; second, directive tendencies which arise from association complexes, such as those found in habits of action; and third, egocentric tendencies in which we are conscious of a "personal moment" as directing the course of our thinking and acting. Hence we have real self-activity which is a direct manifestation of the ego. While some of our activities are the result of a physiological causal order, and some are the result of the laws of association, yet a direction can be given to these activities by the purposive or egocentric tendencies. This conception of a directive tendency in consciousness is an attempt to escape a purely mechanical conception of life in which consciousness must be considered as a mere epiphenomenon—a spectator of what is going on, but in no way effective in determining the course of behavior.

**Will as Self-Determination.**—It is quite plain that the most popular way of thinking about the will is to consider it as the activity of a self or ego. It is the self which makes our decisions for us and determines the kind of behavior manifested in our volitional acts. Now such a conception involves the metaphysical subject side of consciousness to which attention was called in the first chapter of the book. It was there pointed out that it is only the *content side* of consciousness that can be observed. We have no empirical knowledge of the subject or ego which is supposed to know and feel and will for us. Only the content of consciousness is revealed to introspective observation. If, therefore, some one asserts that the self does our willing we are unable to affirm or deny the statement upon the basis of observed facts. If it seems reasonable to believe that back of the conscious states themselves there is a self or ego which is responsible for them, then we must consider it only as a theory and not as a fact. What we really need to know, however, is what the will is as content of consciousness. So far we have been unable to find any unique and separate will element on the content side of consciousness beyond the resident and remote images and sensations preceding and accompanying our volitional acts, and the consciousness of a purpose or intention. These are all cognitive factors.

It has been suggested that in all cases where we exert will power to decide upon some line of action, we feel the effort of the will. Is this not the will element or content that we have been looking for? It is generally agreed, however, that this feeling of effort in volitional activity is the sensation of muscular strain coming from the forehead and chest and other parts of the body during the moments of deliberative attention required in deciding between alternative courses of action. We know that at such times we innervate certain muscles, especially those of the head and those controlling the respiratory organs.

It has also been suggested that the so-called "feeling of innervation" is a will factor or representation of the will consciousness. The feeling of innervation is supposed to be the consciousness of nervous energy or nerve impulses sent out from the brain centres to the appropriate muscles, whose activity is required in carrying out volitional acts. If we were not able to sense this outgoing nerve energy, how could we tell how much to send out and to what particular muscles? It is claimed that in volitional movements we are conscious in advance both of the amount and the direction of the nervous energy involved in the movements, and that this consciousness is the feeling of innervation. Here is a first-hand conscious content which apparently originates in and is controlled by the will, and not the conscious content made up of images of past movements, as our analysis has shown the contents of volitional consciousness to be. But the doctrine of the "feeling of innervation" has not been accepted. There is no evidence that we are in any way aware in advance of the nervous discharge from the brain centres to the muscles. James, who does not believe in the "feeling of innervation," says: "The discharge into the motor nerves is insentient, and all our ideas of movement, including those of the effort which it requires, as well as those of its direction, its extent, its strength, and its velocity, are images of peripheral sensations, either 'remote,' or resident in the moving parts, or in other parts which sympathetically act with them in consequence of the diffusive wave."[1] We are, therefore, just where we were in the beginning of our search for a self-determining consciousness, or will content. The feelings of effort and whatever there is of observable experience in the "feeling of innervation" are kinæsthetic

[1] "Principles of Psychology," vol. II, p. 493. For a refutation of the doctrine of the feeling of innervation the student is referred to pages 493–518 of that volume.

sensations originating in muscular strain. They are, therefore, not consciousness of the will.

If we discard the older metaphysical view of the self as a subject or ego, and look upon the self (from the content point of view) as an organized body of conscious content made up of knowledge, thoughts, desires, and ideals which have grown up through experience and have formed a nucleus, or personality, we may be able to get a clearer conception of the volitional process as a self-determining activity. First of all, however, we must understand that the act of willing is a psychical process. The physical movements which carry out the inner will process are merely the physiological results of the willing. The settling of the mind upon a course of action and holding it fast in the field of attention, that, as James has said, is the real act of will—the fiat, or settlement by the self of a mental issue. Now, what idea gains the attention and holds it and, therefore, finds expression, depends upon the nature of the knowledge, thoughts, desires, and ideals which make up the self. Whatever idea is felt as foreign to the empirical self at the moment of decision, is rejected, but whatever idea is in harmony with the self uppermost at the time is reinforced by the self-feelings and becomes identified with the self. In a more popular way we say that we are interested in certain things and ideas—that a given idea is at the time the most interesting project before us. It is, therefore, the nature of the self which determines what additions to itself are to be made. Whatever fits harmoniously into the system of conscious states which constitutes the self at the time is accepted. The impelling force of an idea or imaged line of action is determined, therefore, by the self and the selection or choice of action is made by the self. Sometimes only a small and fragmentary part of the self is active in making its decisions. Overhasty actions result. In such cases the volitional process is not representative of the true self. A passing desire may be indulged, or an idea, illuminated by the momentary flash of passion, may be given the right of way before all the forces of the self are given time or opportunity to take part in determining the issue. A personality which allows a single idea, or the first thing that enters the mind to find expression before it can be reviewed by the larger self, may be said to possess an impulsive will or an "explosive will," as James puts it. Defective inhibitory powers are found in such a personality. The will in the larger sense functions not only in a positive way in bringing about co-ordinated action, but also in a negative way by checking or inhibiting impulsive action. Isolated ideas and desires (ideas and desires not fully co-ordinated with the organized body of knowledge) are impulsive, but when the ideas are organized and the desires co-ordinated into a system, so that each is fixed in relation to the others, then the impulsive character of this larger self becomes volitional.

Since the self is a very complex conscious organization (containing tendencies, impulses, and desires, some of them native and racial and some of them acquired and ideal), conflicts between the different tendencies, impulses, and desires are sure to arise. The self is then arrayed against the self. No issue can take place until the conflicting and antagonistic parts of the self are reduced to a single system of impulses. This may take place either by the suppression of all but one group of impulses, or by the union and modification of all the impulses into a single system. Volitional control really consists in the acceptance of ideas by the organized body of conscious states, which we have called the self. Will is not a new and separate mental element existing alongside our other mental elements, nor is it a mental factor which by its own force represses our instinctive tendencies and primitive impulses, but it is the conative or dynamic side of all our consciousness in so far as it is organized into a united self—as Angell expresses it, "The whole mind active, this is the will."

**Will and Knowledge.**—From the foregoing it is evident that the exercise of the will presupposes a supply of ideas left in the mind by previous experience. In fact there is no will apart from knowledge. It is just at those points where our information is meagre that we show weak conative tendencies. We hesitate and waver and delay in taking a decided stand when we do not possess definite knowledge. We are most easily influenced by agencies outside our own self under such conditions. On the other hand, we are most decided just where we have mastered the facts about us. In many cases, however, we are not master of the facts and we must decide the issue from a limited point of view. All that can be expected under these circumstances is that we make use of all the possibilities within us—that we bring to bear upon the problems all the relevant knowledge we possess, to the end that our decision springs out of the whole self and not out of a fragment of it. The man with a healthy and vigorous will is the man whose knowledge is varied and extensive enough to allow him to look on all sides of any given question calling for his decision. To be able to think clearly is a necessary attribute of a prompt and forceful will. On the other hand, hazy knowledge leads to doubt and indecision, which is the characteristic of a weak and inefficient will.

**Will and Character.**—While it is true that the nature of our volitional action depends upon the kind of character we have, it is probably even more fundamentally true that the kind of character we develop depends upon the will. For character is the fixation of modes of willing—choices organized into habits. Every decision made adds to and strengthens the self in the particular line of thinking and acting which is involved in the decision. The man who has led an upright life is unable to will a dishonorable act. The character of his self has been formed by years of willing, according to the principles of honesty and square dealing, and these principles have become so important a part of his self that they are always on hand on all occasions of deliberation and choice.

**Freedom of the Will.**—We cannot take up a discussion of the freedom of the will without entering into philosophical considerations. Within the limits of scientific psychology we have no method of approaching the larger question of the freedom of that system of conscious states, which make up the self, and which is supposed to be dominated by the will. As far as we know, all the observable elements which constitute the self are definitely and causally related to each other and the rise and fall of the elements within the self takes place in an orderly way, according to psychological laws. We can find no conscious element which is not subject to these laws. Freedom in the sense of absence of law is a conception which transcends the limits of psychology. But since the question of the free will is bound to be raised in the minds of those who approach the study of the will for the first time, we can profitably give it a brief consideration in order that we may at least understand the nature of the problem. Although we believe that we are free to choose between different lines of action, we shall find when we examine the matter carefully that there are many difficulties in the way of this belief.

There are two philosophical theories about the freedom of the will: First, determinism, and, second, indeterminism. Determinism holds that every will act comes out of pre-existing conditions of the self. According to this theory, we are bound to choose in accordance with the nature of the self. Our will is determined by our interests, desires, and ideals, which depend upon what we inherit and what we acquire through experience—upon what we are by nature and what we are by nurture. No one is free from these influences. Indeterminism, on the other hand, holds that the will is not determined by previous conditions and surroundings of the self. The most radical form of this theory considers that will is absolutely independent of any motive for action whatever. According to this theory, it is the will which determines motives for actions, while the will itself is not bound in any way. No antecedent condition of the self has anything to do with the will. What I will to do, for instance, is unpredictable even by an intelligence that is acquainted with my entire past experience and the native characteristics inherited from my parents.

Since psychology looks upon the self as a system of conscious elements which has grown up in a rational way, and can be accounted for by psychological principles, it is evident that we cannot accept the theory of indeterminism. A wholly free and capricious mental element which is not influenced by pre-existing conditions and present surroundings is beyond psychological explanation. In a certain way we may think of the will of man as free, especially when we compare him with the lower animals. The animals are controlled much more than we by the conditions of the present moment, since their behavior depends upon the nature of the present stimulus. Man, on the other hand, is not, as they are, the puppet of the moment, but transcends the immediate conditions of his environment. He is free from the demands of the moment in that he is able to recall past experiences, formulate them into principles and ideals, and use them as guides or cues of action. He may, therefore, adjust himself to more remote conditions which are not present in the immediate environment. In this sense man is free in just so far as his action springs from the broader field of past experiences rather than from the narrower experience of the present moment.

Psychologically considered, every volitional activity can, if we know all the facts surrounding it, be fully accounted for by psychological principles. Really the only meaning of the term "free will" that is compatible with the principles of psychology is that which considers the will free in so far as it is not constrained by external factors but has the opportunity of following out its own nature. In so far, then, as we are not subject to influences external to ourselves and can act according to the dictates of our own nature, we are free.

# CHAPTER XX

## THE SELF

**The Unity, Continuity, and Identity of Personal Consciousness.**—So far, we have been engaged in the task of examining conscious life in a piecemeal fashion. In each chapter we have isolated and described some one aspect of consciousness, neglecting for the time its other aspects. This analytic procedure is necessary in order that we may come to a better understanding of the whole conscious organization. But we must not stop here, for the discrete mental elements have no meaning when standing alone. As a matter of fact, we never find a sensation, a percept, a memory, a reasoning process, a feeling, an emotion, or a will act existing by itself. Sometimes one of these aspects of consciousness is dominant and sometimes another, but whether it is perception, or memory, or emotion, or reasoning, it is not the only mental state or process present at the moment. In each case there is something more—a background of consciousness representing an organized and unified content which hangs together in a unique and personal way. Whatever is thrown upon the surface of consciousness is projected there momentarily as a lesser content upon a larger and more persistent content. No single experience stands alone in consciousness, but is outlined against other experiences which lie outside the focus of attention. Organic and bodily sensations, aches and pains, marginal visual and auditory presentations, fading images of experiences just past, memories of remote or recent scenes, hopes and desires and plans for the future make up this background. If, for instance, the messenger-boy hands me a telegram announcing the death of a friend, the emotion which the news produces and the thought concerning the future of his family are both experienced within the larger conscious content of myself writing a chapter on the self, plus the visual appearance of the top of my desk and the familiar sound of my neighbor's children playing outside, plus the feeling of hunger resulting from a delayed luncheon. All these experiences and many more lie in the background of the consciousness which is experiencing the emotion.

Then, too, consciousness is not made up of a series of separate and discrete mental states. On the other hand, there is a marked continuity in the different experience of every individual. Each experience overlaps the experiences which precede and follow it, so that there is a continuous unity in each individual stream of consciousness. As new and different experiences appear they do not come as sharp breaks in consciousness but as modifications of the growing unity of experiences. The growth of the cumulative experience is so gradual that there remains a sufficient conscious background of old experience to give the whole a self-identity. There is no moment in the normal waking life where this unity, continuity, and identity of conscious experiences can be disregarded. There is, then, an organization of experience into a personal unity in which all aspects and processes of consciousness are represented. This complex organization is the self.

**The Subject Self, or Ego.**—From the very earliest times philosophers have noted the unity, continuity, and identity of the personal consciousness and have sought to explain this unity by assuming that back of the conscious states themselves there exists for each individual a single unanalyzable subject self, or ego, to which the various parts of his experience are presented and unified. Without this self, or *ego*, there would be, it was thought, no means of binding together the different elements of experience into any kind of unity; and further, without such a unifying entity, there could be no continuity or identity of experience. The idea of the dual nature of the self rests upon this logical assumption, and has found its way into popular thought. It seems reasonable to suppose that all the various experiences of an individual must be presented to some single subject self whose function it is to organize them into a personal whole. James refers to the two aspects of the self as the "*knower*" and the "*known*" or the "*I*" and the "*me*." Kant uses the terms *pure ego* and *empirical self* to designate the subject side and the content side of the self.

The difficulty with such a conception of the self in psychology lies in the fact that the subject self or ego eludes observation, and the statements concerning it can never be checked up by actual experience. If we adhere strictly to the facts of conscious life, we must give up the conception of the transcendental ego, or subject self, and turn to the content side of consciousness and try to find the principles of unity, continuity, and identity of the self, in the experiences themselves. We can, I think, make out a self purely on an empirical basis. We shall then have no need for the metaphysical conception of a self back of, and independent of the mental states which constitute actual experience.

**The Empirical Self.**—If the discrete mental states cannot be attributed to an independent self, or psychical being beyond the mental states themselves, then they must be attributed to the *empirical* self, or complex of mental states—to that complex which constitutes the relatively invariable and persistent background of our conscious life. The empirical self is that central and intimate core of conscious content made up of the bodily sensations, familiar thoughts and ideas, memories, feelings, and desires. If now we grant to this background of consciousness, activities, tendencies, and impulses, then we have a self-active conscious content which is capable of taking up new content into itself. In this way the empirical self takes on the function of the "knower." The dynamic aspect of the self is determined by the nature of the elements entering into the conscious states dominant at any one moment. Since all consciousness is functional the self-content is also functional. The empirical self is, therefore, never simply a passive self, for while it is receptive in so far as it receives new content, it is also active in so far as it incorporates or apperceives this new material into the old. The conception of the self as passive is limited to the self when it is receiving impressions from without, as in sensation and perception. Even here the reception of impressions from without cannot take place without apperceptive activity of older experiences already in the mind. The central mass of content is always active in some degree. It is, of course, most active and directive in acts of will.

The identity of the empirical self is manifest in the fact that no content can be assimilated without a body of old experiences which serves as a basis of interpretation. The fact of recognition in itself is evidence of the activity of the empirical self. The unity of the empirical self, together with its continuity and identity, we have already pointed out in the first paragraph of the chapter. We have attempted to make plain the fact that the conscious content of any single moment is not in itself a mere jumble of separate mental states, but an organized unity possessing active tendencies.

**Origin and Growth of the Self.**—The question of the origin of the self goes back to that of the origin of consciousness itself. We have assumed that consciousness was present from the very beginning of the individual's life. In the very earliest stages of life there was no organization or differentiation of conscious experience. The little consciousness which existed at that time was probably only a crude and unformed state of awareness. The first experiences to take form were those coming from the body and its organs (the bodily and organic sensations and pains, such as the cutaneous and muscular sensations, the sensations arising in the action of the heart and lungs, together with those of hunger and thirst, the vague bodily desires and impulses, and the simple affections). Certain of these recurrent experiences formed themselves into the nucleus of the self. Gradually as consciousness of the body and its surroundings became clear and definite, certain experiences were by their very nature more intimate and personal than others and these made up the threads which were gradually woven into the inner strands of the self.

The outlines of the self, which at first included only the bodily experiences, gradually expand as knowledge of the world and our relation to it increases, so that the self comes to embrace a larger and larger content. The self-feeling starting with our body extends to our clothing and personal belongings, our family, our friends, our club, our country, and many other things which come in time to be identified with the self. The growing idea or appreciation of the self gets a social impress very early in its career, since the idea of self is determined largely by what we think others think of us and ours. Our self-consciousness is influenced to a very marked degree by this picture which we imagine others form of us—of our expressed thoughts, likes and dislikes, desires, habits, and behavior, of our financial standing and social position, our family, our friends, and so on. This picture of ourselves which we think exists in the minds of others is a constant factor in the contents of the self and it is implicitly present at all times. There is some truth in the popular statement that we are what others think of us. The functional aspects of the self are also influenced by the social factor. For it is a matter of common observation that we tend, in what we accomplish, to measure up to the ideas which others form of our ability. The social factor is a most important element in the growth of the self.

No sketch of the origin and growth of the self is complete which does not consider the native impulses and instinctive activities which are antecedent conditions of the self. They not only form the basis on which the self builds, they also continue throughout the growth of the self. They color and modify it. The core of the self is the perpetual background of organic sensations, which with the instinctive impulses and activities constitutes the beginning of the self. As new experiences make additions to the self on the conscious side, the formation of habits adds to the reflex and instinctive impulses of the self on the dynamic side. The self must be considered not only as a group of conscious states, but also as a mass of habits, instincts, tendencies, and attitudes.

**Contents of the Self.**—Among the most important factors of the self is the persistent group of tactual, kinæsthetic, and organic sensations, especially the sensations coming from the viscera. In certain cases where pathological conditions have changed the nature of the visceral sensations, there is a noticeable change in the patient's sense of personality. He feels like a different individual. The visual sensations of the appearance of the body are also a factor in the contents of the self. To these elements we may add our settled likes and dislikes. Even the consciousness of external belongings enters into the content of the self. James has suggested that our clothing, our stocks and bonds, our horses and bank-accounts, our family and friends belong in the idea of self in so far as we are conscious of them in relation to our self. These latter factors involve the social element. It is the consciousness of these things as we think they appear to others which is important in our idea of self.

The factors which contribute very largely to the sense of personal identity and continuity are memory and the organic sensations. The fact that we can reproduce former experiences and identify them as our own serves to bridge over what would otherwise be serious breaks in our personality. In certain cases where the strands of memory are broken off altogether the sense of identity is lost. The bodily sensations are fairly constant and continuous and so contribute a thread of identity to the experience of self. There are other factors involved in the consciousness of the self, but in general we may say that the self-content is a persistent and slowly changing conscious complex in which the elements just mentioned are central and constant. In normal individuals the central self-contents manifest no sudden changes, or abrupt breaks, although there may be considerable shifting of the peripheral contents corresponding to the different aspects of the self as manifested under different conditions.[1]

**Consciousness of the Self.**—So far we have discussed the self as a central and persistent core of conscious content. We must now consider the manner in which this self-content is differentiated and set apart from the other contents of the mind. How does the individual come to think of certain of his experiences in a personal and self-conscious way—as having an egoistic reference, while other of his experiences are given a non-egoistic reference? It is quite evident that whatever the origin of "self-feeling" may be, it is the self-feeling that determines what conscious contents are set aside to constitute the self. Before self-consciousness arises no self can be said to exist, for then all experiences are non-personal and neutral.

The young child makes no distinction between the self and the not-self. Indeed, he does not distinguish at first between objects and persons. Gradually, however, it dawns upon him that certain objects (persons) in his environment react in a peculiar and unique manner, unlike the rest of the objects about him. Persons minister to his needs in a way that objects do not. They wash and clothe and feed him. They are peculiarly sensitive to his own acts and modes of experience. At the same time they are capricious in their movements. Sometimes they come when he cries and sometimes they do not. Moreover, they come and go without warning. The child is, therefore, made aware of a certain independence and self-initiative in others which is reflected back to himself. He begins to be conscious of his own independence of action. From this point on he both identifies and contrasts his acts with the acts of those other objects which he comes to know as persons. The development of self-consciousness and the consciousness of others go hand in hand. Self-consciousness is, therefore, a social product

[1] See discussion of the self in chap. I, p. 17.

brought about through the contact with other persons and is the counterpart of his consciousness of other selves. What he discovers in others he reads into his own self, and what he finds in himself modifies and enriches his consciousness of other selves. What other persons think him to be (as manifested in their behavior toward him) is reflected into his own self. What he comes to think of himself he therefore finds in the minds of others.

**The Self and Sensation.**—Having so far regarded the self as a synthesis of elements into an organized whole, we may now reverse the process and consider the self in relation to some of the discrete elements which constitute it. First of all, we shall consider sensations, the simplest kind of conscious content which enters into the self. Hume, the great champion of the empirical method, denied the existence of a self in the form of innate ideas prior to concrete experiences, and held sense-perception to be the source of all conscious life. In the beginning, consciousness is simply a vague accompaniment of bodily existence, but as sensory presentations multiply, certain presentations break through this primitive vagueness and, together with their affective qualities, they are combined into a mental organization which begins to supplement the reflex and instinctive impulses by supplying new impulses of a sensory character. The relation between this beginning conscious-complex and new sensory experiences is twofold: First, the discrete sensory experiences furnish a fund of new material which serves to clear up the older experiences stored up in the complex. Secondly, the self, or organized complex, not only receives these separate sensations, but it goes out to meet the new experiences, selecting and coloring them in accordance with the experiences already crystallized within it. The self, therefore, does not grow simply by accretions of new sensory experiences, but grows by its own selective activity, in the sense that it assimilates only those sensory elements which harmonize with it, and for which it is already prepared.

**Self and Perception.**—This assimilative character of the self is seen to better advantage in perception. Perception, as we have already seen, is an arousal of old experiences within the self by newly entering sensations. In perception the self supplements any discrepancy in the new presentation by supplying it with material in keeping with its own nature. The directive influence of the organized complex of past experience is plainly apparent in perception.

**Self and Attention.**—The organization and growth of the self takes place very largely within the field of attention. This is so because attention determines what presentations enter consciousness and how they are to combine with the conscious elements already in the mind. Attention and the self are not, however, two different factors. Fundamentally, attention is the clearest and most active portion of the self-content. We may agree to the statement that attention is a manifestation of the self provided the metaphysical assumption of a subject self is not implied. For only those things enter consciousness, arouse and hold attention, that possess some elements of similarity to the already assimilated contents of the self; or are in some way represented within the self. In the earliest stages of individual development the self manifests itself through primary or spontaneous attention determined largely by native and instinctive propensities. Later spontaneous attention is a manifestation of a closely knit organization of habitual experiences and acquired tendencies. Interwoven with these native and acquired self actions is secondary or voluntary attention, determined by a new and consciously formed organization of experience. While spontaneous attention is an expression of what the primary and habitual self really is, voluntary attention expresses the conscious effort of the self to reach a higher stage of development.

**Self and Interest.**—In the chapter on attention we saw that interest as a psychological content is dependent upon attention in that it comes into existence only after attention has been directed toward some object or topic of thought. That one's interests are a key to his real self is a commonplace, but it is even more evident when we consider that interest is aroused by those things which readily catch and hold the attention. We are interested in the things which find affinities already within the self. Our interests, therefore, represent both the native and acquired characteristics of the self. As the self develops they follow the lead of voluntary attention and the simple affective states of pleasantness and unpleasantness.

**Self and Feeling.**—There is a tendency in certain quarters to look upon the self as a "feeling-complex," with affection as the fundamental background or real unifying principle in the self. Accordingly, the real self is considered to be an organization of affective life which manifests itself in the *appreciation* of values in the things about us rather than in the intellectual apprehension of the things themselves. The real world is a world of values and the real self is a feeling-complex, and its relation to the world is an affective, not a cognitive one. However attractive this may be as a philosophy of the self, it finds little psychological support. While it is true that the self does manifest itself as "feeling" or affection, it is never purely affection and nothing else. Indeed, in the author's opinion, there is no reason to consider the affective phase of the self as fundamental. The self is certainly never purely a single phase of consciousness. It is just as truly a sensation-complex, an attention-complex, a knowing or willing complex, as it is a "feeling-complex," and each of these phases contributes to the more ultimate complex—the self.

It is true that the strong feelings or emotions appear to affect the self more than any other conscious content. An emotion seems to shake the self to its very foundations. The explanation of this rests not in the fundamental or deep-seated character of the affective elements, but in the inhibitory effect of the emotional stimulus upon the cognitive activity of the self. We are familiar with the twofold relation between the self and newly entering material. First, the new material, perceptual or ideational, commands entrance to the self-content. Secondly, the self-content goes forth to meet the new experience, or, as we have said before, reacts to it and determines by its reaction the nature of the final impression. Now, in the case of emotions the apperceptive side of the self is taken off its guard, so to speak, and the second, or efferent movement of the self, is inhibited. As a result, the incoming impulse from the stimulus permeates at random through, perhaps, the entire self-content, causing a mass of random and diffused motor reactions which characterize the emotional seizure. One must not mistake the spectacular reactions of emotion for a fundamental movement of the self. Really, emotion or feeling is not related to the self, as it is sometimes claimed, in any more basic way, nor does it make up the contents of the self any more fundamentally than do cognitive states of consciousness.

**Self and Will.**—We have already called attention to the changing character of the self. Now one aspect of the self is prominent and now another. The self consists of a more or less changing complex of active impulses, desires, purposes, thoughts, feelings, and bodily sensations. These are projected against a relatively more stable and invariable background-content made up of habitual modes of thinking and feeling which, although not always active, are nevertheless potential in the self. Thus we may distinguish between the *immediate*, or *present self*, consisting of the contents active at the moment, and the more remote or total self, including dispositions laid down by past experiences which are drawn into the present self in varying degrees at any moment. Now the self that determines action and manifests itself in volition is the present self. What a man does in a volitional way depends upon what elements of his potential self are active in the present self at the time of his decisions. The greater the number of such elements active in the present and temporary self the more do his actions spring from his total self, and the more do they represent his will.

**Sleep and the Self.**—If the self that we know is merely a series of overlapping conscious states, or even a system of conscious contents, how can we explain the fact that after the interruption of sleep the self takes up the threads of experience just where they were broken off? If we assume the existence of an ego, or subject self, the interruption of sleep offers no very difficult problem. We may then suppose that the ego joins the broken ends together and allows the self-content to go on in a continuous stream. If, on the other hand, we hold to the empirical point of view, we must explain the continuity of the self in terms of content alone. We have then no metaphysical self to join the broken parts together. There is, however, some reason to believe that sleep is not an absolute break in the conscious content, but a state of reduced consciousness in which the higher synthetic processes only are suspended, while the bodily or organic sense-impressions and perhaps those from some of the special senses are registered in a lowered form of consciousness. There is some empirical evidence in support of this theory. The following facts point to the continued existence of some form of consciousness during sleep. In certain cases of ill-health we are often vaguely aware of organic sensations or conditions which pervade our sleeping moments like a wraith. Although asleep, the tired mother may hear every sound made by her sick child. Some persons are able to judge the lapse of time during sleep in a remarkably accurate manner, and are able to awaken at any moment they have appointed before going to sleep. How can such conditions exist, if during sleep there is a state of absolute unconsciousness? Locke, on the other hand, held that consciousness may at times wholly disappear. If this is true, we are forced to assume the existence of a subject self, or else attribute the bridging of the gaps in the self-content to physiological or brain conditions entirely.

We cannot decide the question for the periods of deepest sleep, but in light sleep there can be no doubt of the fact that a kind of vague conscious awareness is still present, although attention is almost completely dispersed. The directive agency of higher consciousness becomes less and less effective as we pass into the condition of sleep, and finally the associative connections between presentations are so weakened that our experiences fail to be synthetized and, therefore, cannot be recalled. It is just at this point that introspective observation fails to report anything beyond the presence of a vague unorganized and unconnected awareness which defies description. As the associative connections weaken, the associations become more and more irrelevant, and the period just preceding sleep may be marked by the most bizarre images and intangible creations of fancy.

Measured by the intensity of stimuli necessary to awaken sleeping subjects, the depth of sleep increases rapidly during the first hour, and then becomes rapidly lighter during the next hour and remains light until waking. The physiological causes of sleep are supposed to be the exhaustion of the cell substance in the brain, and the presence of waste material, or fatigue products, in the blood. The blood-vessels in the brain are relaxed and blood-pressure is lowered during sleep. Likewise all the rest of the vital processes are reduced in activity. If the self continues to exist during sleep it is at best an attenuated ghost of the waking self.

**Dreams and the Self.**—Dreams mark those periods during sleep when the synthetic and associative tendencies of consciousness reassert themselves. They never, however, completely re-establish themselves, for it is quite evident from the nature of dreams that only a fragmentary part of the self is active in directing the course of the conscious processes. All kinds of strange associations are formed during dreams as a result of this lack of control. Many conscious tendencies which are either too trivial, subsidiary, or vague to occupy the full attention of waking life, together with those that are consciously inhibited or suppressed for certain reasons, tend to seek expression. When the censorship of the waking consciousness is lowered in sleep, these tendencies find an outlet in dreams. Dreams may be started by external stimuli, but the dream consciousness may not be at all in keeping with the nature of the stimuli. Dreams seem to have little regard for things as they really are. Dreams which occur shortly after falling asleep are often related to the things which occupied the mind during the day just closing. It has also been said that dreams of the early morning anticipate the events of the coming day as planned on the evening before, and that the dreams of deep sleep are representative of the remote past.

It has been claimed that the rate of flow of conscious states is very much more rapid in dreams than it is during waking consciousness, but as far as the author can determine there is little difference in this respect between dream consciousness and flights of reproductive imagination in waking hours.

The psychiatrist Freud has proposed an interesting theory of dreams. He believes that dreams are symbolically representative of our secret wishes and desires, or ideas, that are repressed during the waking life. When the inhibitions of the waking self are removed, these secret wishes and desires rise to the surface and find expression in our dreams. Freud holds that emotional experiences of youth, usually of a sexual nature, may be suppressed and covered up to such an extent that they are half forgotten. They nevertheless remain at the bottom of consciousness as disturbing "complexes," which in many cases are the cause of *hysteria*. These complexes manifest themselves in the dream-life of the patient, but since the dream does not afford adequate expression they remain beneath the surface of consciousness as obsessions of which he cannot rid himself until they are brought out into the full light of waking consciousness. Freud therefore analyzes the dreams of his patients for the purpose of discovering the nature of the "complexes." He then forces a complete expression of the emotional experiences and relieves the mind of its incubus. We cannot pass upon the correctness of Freud's theory of dreams, but it seems reasonable that impulses and tendencies that have for various reasons been denied expression in the past should attempt to find an outlet whenever a lapse occurs in the continuity of rational consciousness.

**Disturbances of the Self.**—We have seen that the self is an association of different conscious elements into a relatively stable organization characterized by unity and identity of experience. Although the contents of the self are constantly changing, there is in the normal self no fundamental break in its continuity. There is always some associative link between the different self-contents.

Now, while this statement is true in the main, it is not absolutely true, even of the normal self. The different parts of the self are not always bound together into a single stream of consciousness. It often happens that different mental processes take place independently of each other, and yet they may be carried on at the same time. For instance, a skilful musician may carry on an animated conversation with one of his auditors and at the same time play a difficult selection on the piano. His consciousness is divided into two parts, which are independent of each other. His musical consciousness is split off from the rest of his consciousness engaged at the time in conversation. He may be unaware for brief periods of his musical consciousness, which may in the meantime lead him from the particular selection he is playing to an entirely different selection. This splitting of consciousness into independent fragments, or the breaking down of the unity of the self is technically known as "dissociation." In the normal self, however, dissociation of consciousness is only temporary and partial, and the momentarily severed parts are later brought together, thus preserving the unity of the self. In abnormal cases, the power of bringing the dissociated parts together is lost. There are many forms of dissociations of consciousness which may be considered as disturbances of the self. We will consider very briefly some of these dissociations of consciousness under the headings of "mental blindness," "automatic writing," "somnambulism," "hypnosis," "multiple personality," and "insanity."

**Mental or Psychic Blindness.**—Certain cases of dissociation manifest themselves in mental blindness or the inability to recognize ordinary objects when plainly seen. This condition is caused by disintegration of the associative connections set up by the different past experiences of the objects. Analogous to this condition is the inability to recognize and interpret sounds (mental deafness). While a lesion in the brain involving the associational pathways may furnish a structural basis for the dissociations, it may be brought about functionally by suggestion in hypnotized subjects or in hysterical persons. The hypnotized subject can be made mentally blind to a certain object in the room through the suggestion of the hypnotist. If asked then to name the objects in the room, he will call off each one, excepting the one involved in the suggestion. The consciousness of that object is split off from the rest of his experience and fails to connect with it. It does not, therefore, make any impression upon him at the time. A hysterical patient may also become mentally blind to certain objects or he may manifest various forms of sensory anæsthesia. A certain part, or all, of his skin surface may become apparently insensitive to all forms of stimulation. Anæsthetic patches were in earlier times called "devil's claw" and were supposed to be the mark of a witch. In such cases of "hysterical anæsthesia" the weakened nervous condition makes it possible for certain experiences to slip away from the unifying process of the self, although they are really presented. In a perfectly normal individual these sensory experiences are always integrated into the self.

In these functional cases we are probably not dealing with absolute lack of awareness of the sensations, but with mental experiences which are split off or dissociated from the rest of consciousness, and which still exist in a subconscious form. Sometimes it is possible to tap this secondary consciousness and prove its existence. It is quite likely that the supposed unconsciousness in hysteria is not unconsciousness but a form of dissociated consciousness which fails to connect up with the rest of consciousness.

**Automatic Writing.**—The phenomenon of automatic writing, sometimes met with in normal individuals, but more often in cases of hysteria, also points to the existence of mental states which are dissociated from the self. If, while a hysterical patient is deeply interested in reading, or engaged in an animated conversation, or his attention held in some other way, a pencil is placed in his hand, he will often begin writing. If questions are whispered into his ear, he may be induced to write answers to these questions while his attention is wholly absorbed in the reading. He is entirely unconscious of what his hand is writing, although what he writes may relate to certain parts of his past experiences. Not only is the stream of his consciousness divided into two independent parts, one engaged in reading and the other in writing, but the writing consciousness is formulating ideas concerning a part of past experience which has been previously dissociated from the self. The two streams of consciousness are ignorant of each other's existence. The self is temporarily dissociated into two systems of consciousness, each engaged in two different and independent activities, and involving two separate sets of memories. While such dissociations are not different in nature from the ordinary dissociations found in a normal self, they differ in the fact that the isolated fragments of consciousness remain separate contents of the self, and are not unified as in the case of the normal self. In fact, the presence of buried memories of certain past experiences in the subconscious mental life is now considered as the cause of hysteria. Although these memories are not resuscitated and brought to the surface, they nevertheless remain active as subconscious and suppressed tendencies, or "complexes," which are constantly seeking the expression which is denied them. They exist only as abnormal disturbances of the self. If by any means the physician is able to bring these suppressed complexes to the surface of the patient's consciousness and cause him to give full expression to them and thereby unite the broken parts of the self, the symptoms of hysteria disappear. It is for this purpose that the methods of psychoanalysis are employed. By skilful questioning and probing through association experiments or even through hypnosis, the patient may be led to open up the disturbing complexes.

**Somnambulism.**—While the term somnambulism is popularly applied to sleep-walking, it includes various forms of dissociated mental states in which the stream of consciousness, instead of being split into two separate streams, both going on at the same time, as in automatic writing, is broken off abruptly and is replaced by an entirely different set of mental states, of which the self has no knowledge. These dissociated mental states are entirely severed from the normal self. The somnambulist may, while asleep, answer questions, carry on a conversation, get up and hide a certain article in the room, or even write down the solution of a mathematical problem, and yet when he awakens be totally ignorant of what he has done. The somnambulistic states are, however, connected with each other. This fact is illustrated by the case, known to the author, of the boy who found in a somnambulistic state a favorite toy that he had hidden while in a previous similar state. In his waking condition between the somnambulisms he could not find the toy and had no knowledge of hiding it.

These milder forms of dissociations during sleep may occur in highly nervous but otherwise normal persons. In hysterical persons somnambulism may take place spontaneously during waking hours. The trance of the medium, the ecstatic state of the religious fanatic are usually somnambulistic states which are completely dissociated from the normal self.

The case of "Irene," reported by Janet, is a form of somnambulism belonging to the border-land between sanity and insanity. Following a prolonged and extremely painful experience connected with the death of her mother, Irene began to show symptoms of a mental breakdown. Suddenly while engaged in her daily duties she would stop short and begin to live through the scenes of her mother's death. During these seizures she appeared to be unconscious of what was going on about her. She did not hear or see those who spoke to her. She was oblivious of everything but her former experiences, which she was reliving at the time. The somnambulism would end as abruptly as it began, and the patient would take up whatever she had been doing where she left off, apparently unaware of the interruption. In a few days the same scenes would be re-enacted. Janet found that during her normal intervals Irene could not recall any of the events connected with her mother's death. These experiences had become completely submerged in her mind. She talked about her mother without emotion and manifested a surprising indifference toward the subject of her sickness and death. In this case we see a complete dissociation from the normal self of a whole group of experiences. These experiences could not be brought to the surface of consciousness, and yet they were present as an isolated system of ideas in her subconscious life. We shall find a similar dissociation of the self in hypnotic states and also in cases of double personality. When the dissociated system of ideas comes to the surface and takes the place of the normal consciousness for any length of time, this system forms the basis for the development of a second personality separate and apart from the normal personality.

**Hypnosis.**—Hypnosis is an aberration of the self, induced by suggestion, in which the content of consciousness is narrowed down to the suggestions of the operator or hypnotist. To these suggestions the subject is abnormally sensitive. In the hypnotic state the mind of the subject is impervious to everything except the thoughts induced by the hypnotist. The self-initiative of the subject is temporarily in abeyance, and no inhibitory ideas arise. Consequently the subject believes everything that the hypnotist tells him and carries out his requests mechanically. If told that in the middle of the room there is a tree filled with ripe cherries, he will pick and eat them as though they were real. He will stand on his head, swim in an imaginary pool, or fight imaginary hornets, or execute other trivial acts in accordance with suggestions, or, if the intimation is given that he cannot move his arms, he finds himself unable to do so. In some subjects a rigid or cataleptic condition of the muscles may be induced by suggestion.

The first stages of hypnosis resemble sleep. Then follows a stage similar to somnambulism, or sleep-walking, in which every idea put into the mind is carried out automatically. When the subject regains normal consciousness, he has no recollection of what happened during the state of hypnosis. There is a complete dissociation between the normal self and the self of hypnosis.

During hypnosis there may be marked changes in the acuteness of the senses. Both hyperæsthesias and anæsthesias may take place under the influence of suggestions. The hypnotized person is very sensitive to all forms of sensory stimuli coming from the hypnotist with whom he is "en rapport." On the other hand, certain sensory experiences may be banished from consciousness through suggestion. It is because of this fact that hypnotism has been employed to a limited degree in certain minor operations instead of the usual anæsthetics. Its use in surgery has not been wide-spread because of the difficulty of control. The therapeutic value of hypnosis has been recognized by a few medical men, but even here its use is very much restricted, although milder forms of suggestion are very widely and successfully used by physicians.

The power of inducing hypnosis is not a mysterious or occult gift. It consists merely in the ability to attract and hold the attention of the subject and to give suggestions in a convincing manner. Hypnotic suggestions are not transmitted to the subject through any unusual channels, but, like all other suggestions from without, they pass through the ordinary sense pathways. The earlier theory that magnetic emanations of some kind are given off by the hypnotist is now discredited.

No normal person can be hypnotized for the first time against his will. By refusing to accept the first suggestions offered, one may keep alive his normal mental resistance to suggestions. In order to pass into the state of hypnosis the subject must voluntarily give all his attention and follow the direction of the operator. Anything that weakens the internal resistance of the self—fatigue, drowsiness, relaxed mental tone, lack of self-confidence, confidence in the operator—will aid in bringing about hypnosis.

There is a marked difference among individuals in normal suggestibility. Some take suggestions easily, being perfectly willing to follow the lead of others and allow them to assume responsibility for whatever is done. Others are not subject to the domination of ideas that they themselves have not passed upon. Whether the difference in the ease with which different individuals take hypnotic suggestion coincides with this difference in ordinary suggestibility we are not at present able to determine.

Posthypnotic suggestions are suggestions given during hypnosis, to be carried out after the subject has regained normal consciousness. In many cases these suggestions are successful. The individual does not remember the nature of the suggestion, but at the time appointed he feels impelled without knowing why to perform the suggested act. What really happens is that there is a recurrence of the hypnotic condition and the deferred suggestion is carried out under its influence.

Hypnotic sleep may be induced in various ways: By placing the subject in a relaxed and comfortable position and reiterating again and again the suggestion that he feels drowsiness creeping over him, that he will fall asleep, one may in many cases bring about the condition. Or the same effect may be produced by requiring the subject to fixate a bright object or a set of rotating mirrors, or by exposing him to a sudden flash of light or unexpected sound, or by allowing him to listen to very soft and monotonous music until the attention is dispersed sufficiently for suggestions to take effect easily. Some operators stroke the forehead or pass the hands in front of the subject's face while suggesting sleep.

There has been much discussion as to whether hypnosis is a pathological condition or an exaggerated form of ordinary suggestion. The modern tendency is to consider it as an extreme form of suggestion, to which the self as a whole is unable to offer any opposition because of its temporary dissociation. In ordinary suggestion the associational and directive tendencies of the self are intact, *i. e.*, the will is in command, but in hypnosis they are not effective. The normal interplay of motives is inhibited and the power of mental resistance broken.

**Double Personality.**—In cases of somnambulism, the dissociated systems of ideas are relatively simple, limited in scope, and remain on the surface of consciousness only for brief intervals. Usually, too, the adaptive reactions of the patient are crippled or entirely absent, as in trance states. In some cases, however, the dissociated system of conscious states becomes extended and comes to the surface for long periods of time, thus displacing the normal self. While the patient forgets all his past experiences, his name, his family and his friends, he may be able, nevertheless, to adjust himself sufficiently to his environment to travel and even to earn his living. The dissociated consciousness constitutes a second personality. After this second self has occupied the stage for some time the real self may return and resume command. The patient is then bewildered and unable to orient himself, since he has no knowledge of the things which happened during the reign of the secondary self. In some cases these different selves may alternate, first one and then the other assuming control.[1]

The following account of a representative case of double personality is taken from James's "Principles of Psychology," volume I, page 391. The subject, the Reverend Ansel Bourne, of Greene, Rhode Island, had been brought up to the trade of a carpenter, but upon being converted from atheism to Christianity he had become an itinerant preacher. Previous to the dissociation of the self, he had been subject to headaches and temporary fits of depression, and had had spells of unconsciousness lasting an hour or less. He also had a partially anæsthetic area on the left thigh. He was known in the community as a man of upright character.

"On January 17, 1887, he drew $551 from a bank in Providence, with which to pay for a certain lot of land in Greene, paid certain bills, and got into a Pawtucket horse-car. This is the last incident which he remembers. He did not return home that day, and nothing was heard of him for two months. He was published in the papers as missing, and foul play being suspected, the police sought in vain his whereabouts. On the morning of March 14, however, at Norristown, Pennsylvania, a man calling himself A. J. Brown, who had rented a small shop six weeks previously, stocked it with stationery, confectionery, fruit, and small articles, and carried on his quiet trade without seeming to any one unnatural or eccentric, woke up in a fright and called in the people of the house to tell him where he was. He said that his name was Ansel Bourne, that he was entirely ignorant of Norristown, that he knew nothing of shopkeeping, and

[1] For accounts of alternating personalities see James's "Principles of Psychology," vol. I, pp. 379–393. The case of Sally Beauchamp, now quite well known to American readers, is described in "The Dissociation of a Personality," by Morton Prince. Boris Sidis gives a very interesting case in his book, "Multiple Personality."

that the last thing he remembered—it seemed only yesterday—was drawing the money from the bank, etc., in Providence. He would not believe that two months had elapsed. The people of the house thought him insane, and so at first did Dr. Louis H. Read, whom they called in to see him. But on telegraphing to Providence confirmatory messages came, and presently his nephew, Mr. Andrew Harris, arrived on the scene, made everything straight, and took him home."

It should be remembered that double personality manifests itself only in persons already possessing unstable pathological tendencies.

**Insanity.**—In early times insanity was considered a manifestation of some supernatural agency, and the insane were either revered as holy, or looked upon as victims of some evil spirit. Hippocrates, the father of medicine, was among the first to oppose this superstition. He believed that the brain was the organ of the mind and, therefore, that mental disturbances were due to abnormal conditions in the nervous system. In modern times this physiological conception of insanity has become the prevailing one. We have come to believe that disorders of the mind are based upon disturbed brain functions. While in many cases we are able to point out the definite brain conditions which produce insanity, there are other cases in which we are unable, as yet, to discover any structural defects of the brain. This has led to a general classification of insanities into *structural* and *functional.* The functional insanities are those which reveal no demonstrable abnormality of the brain. It is thought by some that they are due to purely psychical disturbances of the mind, while others believe that further knowledge will enable us to find a physiological basis for them as well.

Even though we may accept the physiological conception of insanity, we can nevertheless take the purely psychological point of view in the study of these abnormal mental phenomena. If we take the psychological point of view we may abstract from the brain conditions which cause insanity and confine ourselves to a description of the mental changes and conditions which insanity exhibits. The psychological conception, then, looks upon the phenomena only as states of mind, and does not attempt to go beyond the realm of mental facts.

The actual cases of insanity exist in so many varied forms that the task of classifying them is a very difficult one. We may, however, without going into the matter very deeply, call attention to the most prominent characteristics which differentiate the disturbances of the self. Insanity may be defined as a change or disturbance of the self which renders it incapable of functioning in a normal way. These changes may affect the self as a whole, or they may affect only a single part or function of the self. The former mental defect is a quantitative change consisting in a lessening of the general mental capacity of the individual. He loses his ability to think and act efficiently, his intelligence degenerates and he becomes a being of low and enfeebled mentality. This condition is known as *dementia.* Its character is best illustrated in the decay or weakening of the mind which accompanies extreme old age, when it is spoken of as *senile dementia.* Dementia, however, may occur at any age, and may manifest itself in various degrees of loss of intelligence, from a slight lowering of mental power to an almost complete loss of mentality. Dementia is acquired. The patients have been at one time persons of normal mental capacity but mental decay has destroyed their powers.

Besides these acquired forms of weak mentality, there are other forms which are not acquired, but congenital. They are known as *feeble-mindedness*, and are not usually considered among the insanities. The feeble-minded are born with a weak mentality and never attain a normal mental development. They are sometimes referred to as cases of arrested mental development. Feeble-mindedness may exist in all degrees, ranging from the lowest grade of mentality to a condition which is only slightly below normal. It has become customary to group the feeble-minded into three classes —*idiots*, *imbeciles*, and *morons*. The idiot possesses only the lowest level of intelligence. He never reaches the plane of spoken language and is, therefore, incapable of speech. He can understand and use simple gestures, but he is unable to care for himself. He requires the same kind of oversight that is given to a very young child. His mentality does not exceed that of a child of two years.

The imbecile possesses a slightly higher degree of intelligence. He is capable of understanding spoken language and learns to talk himself, although he is incapable of learning to read and write efficiently. His knowledge remains in a very elementary stage and never reaches the plane of general ideas. His mental development corresponds to that of children from two to eight years of age.

The moron represents a still higher degree of mental development. In addition to the acquisition of spoken language he is capable of learning to read and write, and in many cases is able to earn a living in the simplest forms of labor. His mentality corresponds to that of children from eight to twelve years of age. The mental inferiority of the idiot, the imbecile, and the moron is in most cases congenital, and is due to a defective heredity. The offspring of weak-minded individuals are as a rule weak-minded, also. In some cases mental inferiority is due to a pathological taint in the parents who are otherwise normal. In a few cases it is the direct result of such organic diseases as meningitis and scarlet fever.

While dementia and weak-mindedness are both quantitative defects of the mind as a whole, there are other alterations of the self which may be regarded as qualitative in nature. These qualitative changes are often temporary in character, although in some cases they are more or less permanent. With a few exceptions they are regarded as recoverable kinds of insanity. These cases are marked by the general psychic attitude which the subject takes toward his experience.

Three of the most common attitudes are those of *excitement depression*, and *indifference*.

*Mania* is the most common form of mental excitement. The maniac exhibits an abnormal excitability, shown in violent motor activity and rapid flights of ideas. He talks rapidly and constantly, jumping from one idea to another without logical connection. He does not carry out any connected train of thought. His movements are erratic and constant. He occupies himself first with one thing and then with another, beginning a new task every few minutes. His attention is easily diverted from whatever he is doing. The maniac is usually in a state of emotional excitement. Generally he is abnormally pleased with himself and everything about him, although his emotional tone may change to that of irritability or violent anger at the slightest provocation. In some extreme forms the emotional excitement reaches the highest pitch. The patient becomes unmanageable and attacks those about him.

*Melancholia* represents the opposite psychic attitude of depression. Here the patient is abnormally slow in thought and speech. He sinks into a state of deep misery and unhappiness, from which nothing is able to raise him. He continually broods over his real or fancied misfortunes.

*Dementia præcox* manifests the psychic attitude of indifference. The patient lacks interest in the things about him. He pays no attention to the things which the normal person is keenly alive to. He has no hopes, or plans, or ambition, and is content to remain in his present condition. He is untidy and slovenly in his dress and habits. There is a loss of personal modesty due to the lack of a proper emotional attitude. The stream of thought is shallow and weak, and conversation is incoherent and unintelligible. This form of mental aberration appears in the young usually about the age of puberty, and is progressive. Absolute indifference or apathy is also manifest in *apparent* or *emotional dementia*. In these cases the patient really possesses mental capacity, but because of his abnormal emotional indifference he does not use it in any way. He sits in one position for long periods of time, motionless and inert, making no effort whatever, even to answer simple questions addressed to him. He shows no interest in the happenings that take place around him. It is impossible to arouse him from his mental lethargy.

There are other forms of insanity which involve disturbances on the intellectual side of the self. While emotional changes accompany these intellectual aberrations, they are secondary—not primary, as in the preceding cases. *Paranoia*, for instance, is primarily an abnormality of the intellect. A patient who apparently is normal in other respects may become the victim of some delusional idea, or may be subjected to hallucinations which he is unable to distinguish from the reality about him. A false idea may spring up in his mind which he is unable to correct. He may believe that his arms are made of glass or that some person is persecuting him by trying to poison him. For this reason he may refuse to take food. He thinks he hears threatening and insulting voices which he takes to be real, although in other things he seems perfectly rational. As a result of these delusional and hallucinatory ideas the patient loses his mental equilibrium and begins to act strangely. On the other hand, the patient may develop "delusions of grandeur." He entertains an exaggerated idea of his own importance and frequently looks upon himself as some celebrated character, a millionaire, great inventor, King, or savior of the world, without realizing the discrepancies between his real and his fancied condition. Frequently delusions of persecution and delusions of grandeur are combined. The patient may think himself a great inventor, but that certain persons are stealing his inventions and conspiring to deprive him of proper and rightful recognition by the world.

Thus we see that *hallucinations* and *delusions* play an important and varied part in the insanities involving the disturbances of the intellectual side of the self. Hallucinations are false perceptions, through which the patient becomes aware of objects having no real existence. Auditory hallucinations are very frequent among the insane. Some patients are repeatedly hearing voices which threaten or reproach them. Since these are believed real, they become serious disturbances of the self.

While hallucinations are false perceptions, delusions are false beliefs. Thus, if a patient sees, or hears, or in any way senses an object which has no objective existence, he has a hallucination, but if he believes that he is the Emperor of China, or that everybody is trying to put poison in his food, he has a delusion. A delusion may become the basis for an entirely new system of view-points and reactions. Everything is changed and distorted to agree with the delusional belief. An important characteristic of a delusion is its perseverance. No argument is able to dispel it. The most convincing proof of its falsity is of no avail.

*Obsessions* comprise another form of intellectual abnormality, which, although in a way similar to delusions, are to be distinguished from them. Delusions carry with them the belief in their reality, while obsessions do not. An obsession is the persistent presence of an idea, or other psychic element in consciousness, in spite of all efforts to banish it. A very frequent obsession is the so-called "washing mania," in which the patient feels that his hands are soiled and must be washed. He *knows* that they are not soiled, but he is impelled in order to rid himself of the idea to wash his hands every few minutes during his waking hours. He is not deluded intellectually, *i. e.*, he does not *believe* that his hands are dirty, but he cannot get the insistent idea out of his mind. Obsessions exist in various forms, from the impulsion to count every crack in the sidewalk to the insistent idea of killing one's own mother. Obsessions are found most frequently in those cases of nervous debility (neurasthenia) which lie on the border-land between sanity and insanity. In some cases the overweighting of an idea may be so persistent and pronounced as to overbalance the rational structure of the self and produce insanity.

*Hysteria* is also a form of self-alteration which can hardly be classed among the insanities, and yet, at times, it approaches very near if it does not reach the stage of insanity. It shows itself in a highly exaggerated impressionability and suggestibility, in undue attention given to the self, and in an abnormal desire for sympathy. It also exhibits marked disturbances of sensations and of motor and glandular activities. Loss of sensations (anæsthesia) may appear in certain areas, sometimes to such an extent that needles may be thrust into the skin without causing pain. The areas may vary in size from a small patch to that of the whole skin. In some cases there may be a heightened sensibility (hyperæsthesia) and in some a distorted or perverted sensibility (paræsthesia). The fact that an exaggerated suggestibility is a marked characteristic of hysteria has led to the belief that it is due to subconscious states of mind not unlike those found in the hypnotic state. This seems all the more probable since patients are often cured merely by suggestion. While there is a difference of opinion, some authorities look upon hysteria as a functional disturbance depending upon subconscious elements. The mental conditions which are held to be fundamental are disguised by the fact that hysterical patients simulate the effects of various organic diseases. The appearance of such organic disturbances without any structural defects has made hysteria a very difficult condition to understand.

Freud and others believe that hysteria is due to definite emotional shocks which, although forgotten or suppressed, and dissociated from the conscious self, still play a disturbing subconscious part in the mental life of the self. Such subconscious states are termed "complexes." Embedded and held in the depths of the self, they are thought to be the cause of vague, foreboding fears and doubts which often mark the beginning of mental alienation. The method of treatment (psychoanalysis) consists in reviving the forgotten or suppressed experiences (complexes) which were the cause of the emotional shocks and in subjecting them to careful and rational consideration by the patient. When this is done, the dissociated fragments of experience are regained and given their proper value among the other elements of the self. The subject is then relieved of the disturbing influences and regains control of his mental processes and the bodily symptoms of organic disturbances accompanying the hysteria disappear.

Besides the so-called functional disorders which we have just discussed, there are a number of mental disorders usually placed under the head of structural psychoses. Among them are to be noted *general paresis*, or softening of the brain, *choreic psychoses*, *epileptic psychoses*, and *toxic psychoses*, all of which are due to definite structural defects of the brain and nervous system. Many of the psychic disturbances already described also appear in the structural insanities and need no further elaboration in this brief account of insanity.

From the foregoing description of the different disturbances of the self it is evident that they owe their character to a lack of harmony among the elements of the self. Some of the mental processes may become overexaggerated and overbalance the self-structure. The disturbances may manifest themselves on the emotional, the volitional, or on the intellectual side of the self. Accordingly, we find the melancholias and emotional insanities, obsessions, and delusions. Conflicts between different systems of experience within the self may result in dissociations and the formation of complexes which tend to change the relations between the parts of the self and destroy its unity.

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